PEARL

pp. 137-138 abstracted.

The Journal of HEREDITY

A DOMINANT MUTATION IN MAIZE
(SEE PAGE 143)

How Cell-Migration Affects Color-Patterns

The Birth Rate of Wellesley Graduates

A Pedigree of "Cobblers Chest"

Superior Individuals as Group Guides

History of Poland-China Swine

VOLUME 30 APRIL, 1939 NUMBER 4

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President — Vice-President, W. E. CASTLE — Secretary, C. E. LEIGHTY
Treasurer, J. H. KEMPTON
Legal Advisor, STANTON C. PEELLE

EDITORIAL BOARD

Managing Editor, ROBERT C. COOK

M. DEMEREC — R. R. GRAVES — L. C. DUNN
H. J. MULLER — GEORGE M. DARROW — PAUL POPENOE

Members of the Council are ex-officio members of the Executive Board

COUNCIL

W. E. CASTLE, Emeritus Professor of Genetics, Harvard University, and Research Associate of the Carnegie Institution of Washington.
LEON J. COLE, Professor of Genetics, University of Wisconsin.
O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture.
DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.
HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigation, U. S. Department of Agriculture.
SAMUEL J. HOLMES, Professor of Zoology, University of California, Berkeley, California.
J. H. KEMPTON, Bureau of Plant Industry, U. S. Department of Agriculture.
W. V. LAMBERT, Geneticist, Animal Husbandry Division, U. S. Dept. of Agriculture, Washington, D. C.
C. E. LEIGHTY, Agronomist in Charge of Dry Land Agriculture, U. S. Department of Agriculture.
N. D. C. LEWIS, Director, New York State Psychiatric Institute and Hospital, New York City.
MARCUS M. RHOADS, Geneticist, Office of Cereal Crops and Diseases, U. S. Department of Agriculture, Washington, D. C.
SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.
E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.
E. A. BESSEY, Professor of Botany, Michigan State College, Lansing, Michigan.
A. F. BLAKESLEE, Plant Geneticist, Carnegie Institution, Cold Spring Harbor, New York.
W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.
C. B. DAVENPORT, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.
RUSSELL W. DUCK, Livestock Editor, *The Rural New Yorker*, Syracuse, N. Y.
R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.
C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.
C. M. GOETHE, Sacramento, California.
HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.
H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.
D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.
M. A. JULL, Senior Poultry Husbandman, U. S. Department of Agriculture, Washington, D. C.
F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana.
C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.
JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.
H. H. NEWMAN, Professor of Zoology, University of Chicago, Chicago, Ill.
T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.
JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhattan, Kansas.
JOHN W. SCOTT Professor of Zoology, University of Wyoming Laramie, Wyoming.
A. D. SHAMEL, Physiologist, U. S. Department of Agriculture, Riverside, California.
GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.
EDMUND W. SINNOTT, Professor of Botany, Barnard College, Columbia University, New York City. (Representative of A. G. A. on Council of Amer. Assoc. for the Advancement of Science.)
W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.
A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.
W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.
W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.
H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.
H. J. WEBBER, Prof. Subtropical Hort., Citrus Experiment Station, Riverside, California.
E. N. WENTWORTH, Armours' Bureau of Agr'l Research and Economics, Chicago, Illinois.
P. W. WHITING, Zoological Laboratory, University of Pennsylvania, Philadelphia, Pa.

The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 32nd Street and Elm Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 368, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 32nd Street and Elm Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918.

Contents copyrighted 1939 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office

$3.50 a Year. 35c the Copy. Prices of back numbers on application.

The

Journal of Heredity

VOL. XXX APRIL, 1939 No. 4

CONTENTS

DEGENERATION OF THE RETINA AND CATARACT
By M. C. Bourne and H. Grüneberg 131

THE BIRTH RATE FOR WELLESLEY COLLEGE GRADUATES
By Helen Butts Correll 137

THE INHERITANCE OF "HOLLOW CHEST"
By S. Edmund Stoddard 139

HERITABLE CHARACTERS IN MAIZE. 50-VESTIGIAL GLUME
By G. F. Sprague 143

MOUSE-BREEDING MADE EASY
By A. C. Hagedoorn, V. LaBrand and A. L. Hagedoorn 147

A GENETIC HISTORY OF POLAND-CHINA SWINE
By Jay L. Lush and A. L. Anderson 149

THE NEEDS OF SUPERIOR INDIVIDUALS AS GUIDES TO GROUP ASCENDANCE
By W. Franklin Dove 157

CHROMOSOMES OF THE DIAPENSIACEAE
By J. T. Baldwin, Jr. 169

DIRECT CONTROL OF AVIAN COLOR PATTERN BY THE PIGMENTOBLASTS
By C. H. Danforth 173

NOTES AND REVIEWS

BLOOD HETEROSIS IN HYBRIDS 136

MENTAL DEFECT IN GERMANY (Rev. of *Erbkrankheiten.*)
By N. D. C. Lewis 141

GENETICS OF CONGENITAL HIP DISLOCATION (Rev. of FABER, *Angeborenen Hueftverrenkung.*)
By Olga Marum 142

FRENCH POPULATION DECLINES 156

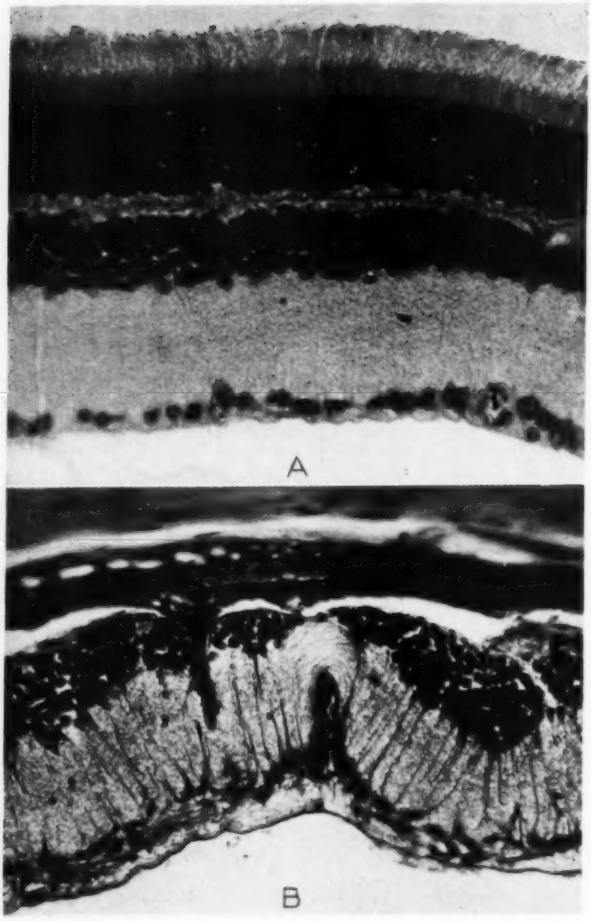
TOWARD A DEMOCRATIC EUGENICS (Rev. of *American Eugenics Today.*)
By Clairette P. Armstrong 163

A B C'S OF THE *A, B, AB*'S 165

A DIONNE SUGAR COATING FOR PARENT EDUCATION (Rev. of BLATZ, *The Five Sisters.*)
By Gladys C. Schwesinger 167

POULTRY HUSBANDRY (Rev. of JULL, *Poultry Husbandry.*)
By S. S. Munro 171

$3.50 a Year ***35c. the Copy***



RETINAL DEGENERATION ASSOCIATED WITH CATARACT

Frontispiece

Photomicrograph of section of normal adult rat retina (*A*) and degenerated retina found in the primary lesion of inherited cataract (*B*). In the normal specimen, the retina has been detached from the pigment epithelium, choroid and sclera. In the abnormal, the outer nuclear and rod layers have completely disappeared, tissue connections have been established between the remains of the retina and the pigment epithelium, and the layered structure of the retina is beginning to be distorted.

DEGENERATION OF THE RETINA AND CATARACT

A New Recessive Gene in the Rat (*Rattus norvegicus*)

M. C. Bourne and H. Grüneberg
Department of Biochemistry and Department of Biometry, University College, London

GENETICAL literature is rich in examples of genes with irregular manifestation. An individual which according to its genetical constitution should have shown an abnormal trait, fails to exhibit it, and it has been shown that such "normal overlaps" may be due to modifying genes or to environmental factors, or to both, which interfere with the manifestation of the gene.

In a number of cases, for instance in acholuric jaundice in man, the normal overlaps are known to be spurious. This disease appears to be due to a dominant gene with irregular manifestation in pedigrees which are based solely on the fully developed anomaly. However, a careful investigation of "normal" transmitters shows that they invariably exhibit peculiarities in their blood, notably a decreased resistance to haemolysis and a globular shape of their erythrocytes. When classification is based on these anomalies, the inheritance of the trait follows a clear-cut dominance. The irregularities in "monosymptomatic" pedigrees are therefore entirely due to the fact that classification is based on a secondary effect, the haemolysis, instead of the primary anomaly in the erythrocytes.

In view of cases of this kind, it has recently been suggested by one of us[7] that irregularity of gene manifestation may generally be spurious. In other words, that gene manifestation is always regular as regards the primary effect, and irregularities become apparent only if the "characters" which are subject to a Mendelian analysis are in fact more or less remote consequences of the primary gene action. In its general form this suggestion cannot be strictly proved; but it becomes more likely with every case where the principle has been shown to apply, and in the absence of evidence to the contrary, it may be deemed applicable to the cases that have so far defied analysis. In this paper we shall present such a case in the rat.

The new gene was first observed in the mixed rat colony of Bemax Ltd. (Vitamin Foods) after it had already spread to some extent. A number of affected animals of both sexes were kindly handed over to one of us (M. C. Bourne).

Nature of Defect

The most obvious anomaly consists of an opacity of the lens (cataract). The cataract has been described by M. C. Bourne, D. A. Campbell and M. Pyke[2] as follows: The first changes in the lens may become noticeable as early as during the second month of life; the majority of animals that develop cataract show the first lens changes during the third month; only a few develop them later, as shown in Table I. An appreciable percentage (about 40 per cent) of the homozygotes never show any signs of cataract in their life, as shown in Figure 3. This chart comprises 63 offspring of matings between homozygotes which lived at least 9 months, the average being 14.3 months. The condition tends to be symmetrical, though differences in intensity of the manifestation between the two sides are common. Major asymmetries in the sense that one eye is heavily affected, whereas the other one is entirely free, do occur, but are rather rare. The time difference between the first observable

RAT SHOWING MATURE CATARACT

Figure 1

The degeneration of the crystalline lens is a variable secondary manifestation of a gene whose primary effect is to bring about retinal degeneration. Not all rats having abnormal retinas have cataract.

signs in the two eyes only rarely exceeds one month.

The first sign of the anomaly is the appearance of a few isolated dust-like opacities, resembling a stippling, near the posterior pole of the lens. These opacities increase in number and intensity, forming some kind of a disc which is roughly circular, but with somewhat irregular outline. General cloudiness of the lens may follow, and eventually the lens may become a homogeneously milky body which transmits practically no light; the cataract is mature, the rat blind. (See Figure 1.) Not all cataracts reach maturity, and the speed of maturation varies considerably. In many animals, only stipples appear, and no appreciable progress of the cataract occurs during many months, or even during the whole life of the animal.

Some of the homozygotes that escape the typical lens changes develop some kind of rudimentary anomaly which seems to be located in the lens epithelium at the back of the lens. The lens substance proper remains clear, but unusual reflections of light in different colors (yellow, green, blue, etc—"shagreen") become noticeable opthalmoscopically. When "shagreen" develops at all it usually does so only fairly late in life. Its actual onset in individual cases is sometimes difficult to determine.

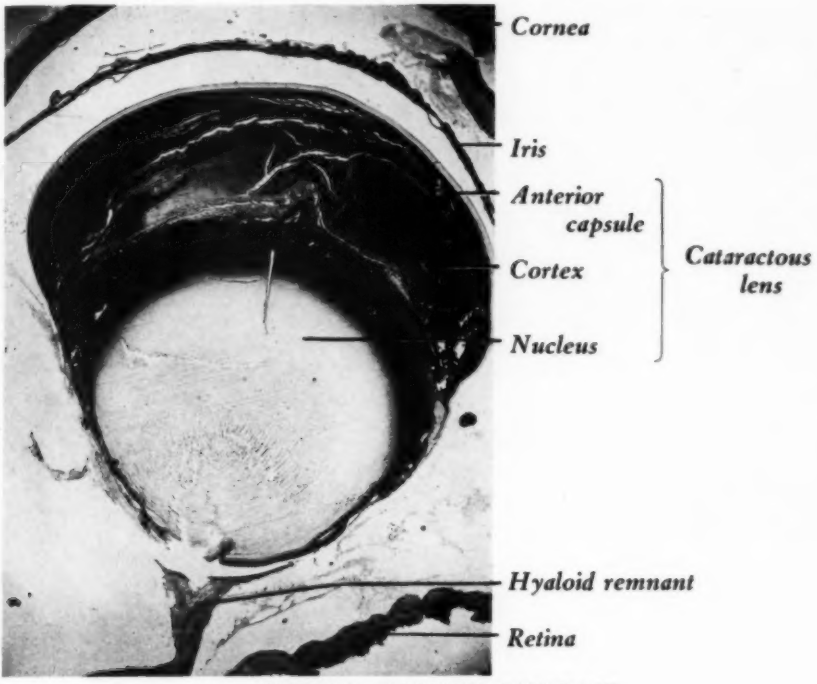
Some affected animals exhibit another anomaly. In early embryonic development the growing lens receives a blood supply by means of a tiny artery, the hyaloid artery, whose branches form a close network on the posterior capsule of the lens. In normal development this blood supply is obliterated and eventually disappears entirely. But in the mutants traces of it persist fairly frequently. They are visible opthalmoscopically as a tiny dot near the back pole of the lens. As such a dot looks rather similar to

TABLE I. First signs of lens changes.

During month	1	2	3	4	5	6	7 and over
No. of rats	0	5	28	4	1	0	0

TABLE II. Backcross results.

		Ophthalmoscopically normal. Retina		
Cataract or typical lens changes	Hyaloid or shagreen	degenerated	normal	not investigated
11	5	5	17	14



SECTION THROUGH CATARACT
Figure 2

Section through the eye-ball showing the terminal stages of the lesion. Note the thickened anterior capsule of the lens, the softened cortex, the remnant of the hyaloid artery, and the very degenerated retina.

the stippled opacities with which the cataract starts, the diagnosis of a persistent hyaloid in the living beast is often difficult and usually only possible in animals that have developed no cataract.

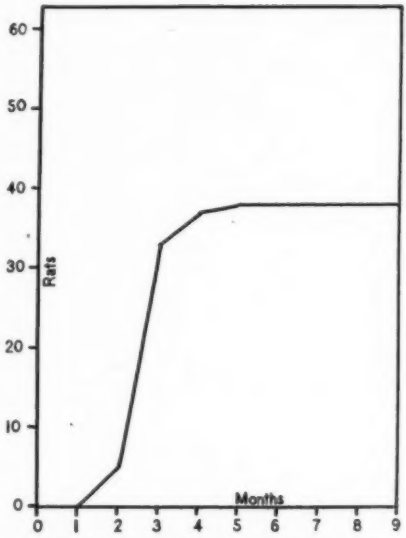
However, quite a number of homozygotes never show any signs of cataract, shagreen, or a persistent hyaloid artery. They would be classified as "normal overlaps."

But a histological study of the eyes shows that all homozygotes, whether they show cataract, shagreen or a persistent hyaloid artery, or whether they are normal opthalmoscopically, exhibit a very characteristic anomaly of the retina. Fifty-two offspring of matings of two affected parents were studied histologically. They all showed degeneration of the retina. Most of these individuals (42) were over 9 months of age (included in Figure 3); of these 21 had either mature cataracts or typical lens changes; 10 had only a persistent hyaloid artery, or shagreen, or both; and 11 were entirely normal opthalmoscopically. But they all showed degeneration of the retina. On the other hand, not a single individual has been found which combined cataract, shagreen, or the hyaloid artery with a normal retina. There is no doubt, therefore, that the primary gene action brings about the retinal changes, and that the other anomalies are secondary. The pathological mechanism which links up primary and secondary effects is as yet obscure, and further research will be necessary for its full understanding.

The development of the retinal lesion

has been described by M. C. Bourne, D. A. Campbell and K. Tansley[3] as follows: the eye of the rat is immature at birth, and does not reach maturity until the animal is about 17 days old. It was found that the eyes of homozygotes of the stock described here developed normally between birth and about 17 days of age, at which time the retina was fully differentiated. (Frontispiece.) The first change in the retina was the death of cells of the outer nuclear layer (the rod nuclei) and this was first observed at about three weeks of age. The death of the rod nuclei was accompanied by the disintegration of the rods themselves and a disappearance of the visual purple. By 12 weeks of age the whole of the outer nuclear and rod layers had disappeared (Frontispiece), and these layers were replaced by a network of glial fibres. At this stage, changes in the pigment epithelium became apparent; this tissue became adherent to the retina and in pigmented eyes, pigment granules from the pigment epithelium migrated into the retina along the path made by bundles of connective tissue and glial fibres (Frontispiece). The lesions progressed, involving the inner part of the retina, until finally the whole of the layered structure of the retina was lost (at about 12 months of age). In the terminal stages (Figure 2) intra-ocular haemorrhages from retinal vessels and aseptic inflammatory reactions in the vitreous could be observed in some cases. No changes in the blood vessels could be observed microscopically in the early stages of this lesion, but in the terminal stages the walls of the blood vessels of the retina and choroid showed hyaline degeneration as a result of secondary changes. The pathological changes occurring in the retinae of these rats bear a striking resemblance to those described in certain cases of the human disease, "retinitis pigmentosa,"[26] and it will be recalled that Treacher Collins[5] advanced the theory that retinitis pigmentosa was a disease resulting from the "abiotrophy" of the visual cells.

Apart from the eye anomalies, no pathological conditions have been observed in the animals. In particular, a rough test has shown that the sense of hearing is unimpaired.



AGE INCIDENCE OF CATARACT

Figure 3

Time of onset of cataract of 63 abnormal rats that lived nine months or over. Of these animals, 25 failed to develop cataract, but all showed degeneration of the retina. Of the rest, all but one individual had shown the first symptoms by the end of the fourth month (see also Table 1).

Genetic Data

The inheritance of the syndrome is very simple. A cataractous male with degenerated retina was outcrossed to a Wistar albino female. Sixteen F_1 individuals were normal ophthalmoscopically, and none of them showed retinal degeneration histologically. So the condition behaves as a recessive. F_1 females backcrossed to their affected father produced 22 offspring. Eleven of these developed lens changes and one showed only a hyaloid remnant in one eye; they all had degenerated retinae; the other ten individuals did not show any lens or other anomalies and had normal retinae. There is, therefore, a very good approximation to a 1:1 ratio. In another set of backcross data only some of the offspring

were scored histologically. These experiments yielded the data given in Table II.

Sixteen animals had some ophthalmoscopically visible anomalies; nine of them were investigated histologically; as expected, they all had degenerated retinae. Of 36 animals normal ophthalmoscopically, 22 were examined histologically, and of these, five had degenerated retinae, being "normal overlaps," whereas 17 were normal. To derive segregation data from these figures, a correction for undetected normal overlaps has to be made. There were 14 ophthalmoscopically normal individuals that were not investigated histologically. As they were of different ages, the correction should be made litter by litter on the basis of normals and "normal overlaps" as scored histologically. If that is done, it is found that 12.13 of the 14 animals were probably true normals and the remaining 1.87 were normal overlaps. The ratio is therefore 29.1 normals : 22.9 abnormals, which again is a good approximation to a 1:1 ratio. Adding the two experiments together, we obtain 39.1 : 34.9 ($\chi^2 = 0.238$ for $n = 1$, P between 0.5 and 0.7). The data therefore clearly show that we are dealing with a single gene difference, and that the gene for retinal degeneration segregates in a perfectly orderly fashion.

Other Cases of Inherited Cataract

Genes producing cataract are common in mammals. They are known in man (Waardenburg[27]); horses (Hurst[10]); cattle (Detlefsen and Yapp,[6] Small[24]); dogs (Maleval,[20] 1904, black poodles; Westhues,[28] various breeds; v. Hippel,[9] Alsatians); rabbits (Kaufmann,[15] Ibsen and Bushnell,[11-13] Nachtsheim[21]); rats (Jess,[14] Sciuchetti and Lambert,[23] Lambert and Sciuchetti[17]) and mice (Pearson,[22] Strong[25]). The inheritance is dominant in some, recessive in other cases; considerable irregularities in behaviour have been noted in several instances, notably by Ibsen and Bushnell in the rabbit and by Pearson in the mouse. Some of the cases are congenital, others develop later in life. Clearly, the group is very heterogeneous, and a detailed comparison with our form is difficult, particularly in view of the fact that in some of the cases the analysis has not been carried very far. The congenital forms, such as in cattle and dogs, are probably of an entirely different nature; the same applies to Strong's case in the mouse where the cataract seems to depend on gross deformities of the eyelids.

As mentioned above, the retinal changes correspond rather closely to retinitis pigmentosa in man, which is not uncommonly associated with cataract. That disease itself seems to be rather a mixed group both genetically and as regards the pathological mechanisms involved. A perusal of Bell's monograph in the *Treasury of Human Inheritance*, and the more modern treatment in Waardenburg's monograph seems to indicate that retinitis pigmentosa is a symptom rather than a causal unit, and in a recent paper Haldane[8] pointed out that this disease may be caused by autosomal, by sex-linked and by partially sex-linked genes. Our gene is certainly not sex-linked, but whether it is autosomal or partially sex-linked will have to be determined by experiments designed for that purpose. Retinitis pigmentosa has been observed as a recessive character in dogs (Magnusson[19]) though in this case no cataract was found. What appears to be an anomaly very similar to our case has been described in the mouse by Cohrs.[4] Unfortunately that anomaly was discovered only after the whole breeding stock had been killed off. The illustrations given by Cohrs show a striking resemblance to our retinal degeneration; in one individual there existed a cataract associated with a persistent hyaloid artery. Nothing is known about the mode of inheritance. The author regards the anomaly as congenital; but as it was only observed in fully-grown animals, there is no proof for this statement. Cohrs further assumes identity of his material with Keeler's rodless retina. As his stock was in no way related to Keeler's stock, and as no crosses have been made, that assumption lacks convincing evidence. As Cohrs' stock is now extinct, we can only draw the reader's attention

to its striking similarity to our case.

It should be mentioned that rodless retina in the mouse differs fundamentally from our gene in the rat because rodlessness is produced by an arrest in development, whereas in our rats, the retina at first fully differentiates, and then undergoes a degeneration of the outer nuclear layer and the rods.

Summary

A new recessive gene is described in the rat (*Rattus norvegicus*) which causes degeneration of the retina, beginning at the age of about three weeks. Later in life, many, but by no means all, of the animals develop changes in the lens which may lead to mature cataract. Persistent hyaloid artery occurs fairly frequently in the stock. The patho-physiological relationships of these anomalies remain to be worked out in more detail; but it is clear already that the development of cataract depends in some way or other on the degeneration of the retina which always precedes it in time. The retinal changes correspond closely to retinitis pigmentosa in man.

The case is a demonstration of the principle that primary gene effects (retina) show a straight-forward mode of inheritance, whereas secondary effects (lens) may tend to exhibit irregularities of manifestation.

Literature Cited

1. Bell, J. Treasury of Human Inheritance. *Eugen. Lab. Mem.* 21:2 Part 1. 1922.
2. Bourne, M. C., D. A. Campbell, and M. Pyke *Brit. J. Ophth.* 22, 608. 1938.
3. Bourne, M. C., D. A. Campbell, and K. Tansley. *Ibid.* 22, 613. 1938.
4. Cohrs, P. *Arch. Augenheilk.* 107:489-500. 1933.
5. Collins, E. Treacher. *Trans. Ophthal. Soc. U. K.* 39:165. 1919.
6. Detlefsen, J. A., and W. W. Yapp. *Am. Nat.* 54:277-280. 1920.
7. Grüneberg, H. *Proc. Roy. Soc. B.* 838. 125:123-44. 1938.
8. Haldane, J. B. S. *Ann. Eugen.* VII: 28-57. 1936.
9. v. Hippel, E. *v. Graefe's Arch. f. Ophth.* 124:300-24. 1930.
10. Hurst, H. L. *Verh. d. Naturforsch. Vereins in Brünn.* 49:192-213. 1910.
11. Ibsen, H. L., and L. D. Bushnell. (Abstract.) *Anat. Rec.* 41:110. 1928.
12. ———. *J. Exp. Zool.* 58:401-21. 1931.
13. ———. *Am. Nat.* 68:92-95. 1934.
14. Jess, A. *Klin. Mon. f. Augenheilk.* 74:49-56. 1925.
15. Kaufmann. *Ibid.* 76:132. 1926.
16. Keeler, C. E. *J. Exp. Zool.* 46:355-407. 1927.
17. Lambert, W. V., and A. Sciuchetti. *Science* 81:278. 1935.
18. ———. *J. Hered.* 26:91-94. 1935.
19. Magnusson, H. *Arch. f. vergl. Ophth.* 2:147-163. 1911.
20. Maleval, M. *Receuil de Méd. vétér.* 81:360-61. 1904.
21. Nachtsheim, H. "Erbpathologie des Kaninchens." *Erbarzt*:1-32. 1937.
22. Pearson, E. S. *Nature* 114:433. 1924.
23. Sciuchetti, A., and W. V. Lambert. *Proc. Iowa. Acad. Sc.* 41:317-18. 1934.
24. Small, Ch. *Am. J. Ophth.* 2:681-2. 1919.
25. Strong, L. C. *Proc. VI. International Congress Genetics.* 2:195. 1932.
26. Verhoeff, F. H. *Archives of Ophth.* 62:392. 1931.
27. Waardenburg, P. J. "Das menschliche Auge und seine Erbanlagen." pp. XII and 631. Haag. Martinus Nijhoff. 1932.
28. Westhues, M. *Arch. f. wiss. u. prakt. Tierheilkunde.* 54:32-83. 1926.

✦

"Blood Heterosis" in Hybrids

Blood analyses of yaks, cattle, and hybrids between them in the Oirat Zootechnical Station* showed that the hemoglobin content, blood alkalinity, and diameter of the red cells increased, whereas the number of red cells decreased, with age. Comparisons of the adult yak and cattle with hybrids showed that the hybrids greatly exceeded the two parental species in the basic indexes responsible for the oxidizing power, such as hemoglobin content, number of erythrocytes, and alkalinity. The better oxidizing capacity of the blood causes a more intense metabolism and more rapid growth. Similar results were obtained in studies, noted above, of hybrids of dromedaries and Bactrians and in mules. *Exp. Sta. Rec.*

*H. F. Kushner (*Compt. Rend. (Dok.) Acad. Sci. U. R. S. S., n. ser.*, 19, No. 3, pp. 185-188. (1938.)

THE BIRTH RATE FOR WELLESLEY COLLEGE GRADUATES

HELEN BUTTS CORRELL

IN 1915 Johnson and Stutzmann[2] published a report on the statistics concerning the number of Wellesley College graduates who married and the number of children they produced. The authors were so impressed with the low rate of reproductivity of this group of women's college graduates that they stated: "Separate colleges for women, in the United States, are from the viewpoint of the eugenist a historic blunder."

From that time until the present no complete study has been made of the percentage of Wellesley College graduates who married and the number of children they produced. The present study, which was made possible through the coöperation of the Alumnae Secretary, is based upon a larger number of records than any previous similar report which has come to the attention of the author. In 1935 the Alumnae Office sent out a bibliographical questionnaire to each of the graduates for whom any address was known. Of this number 45.8 per cent replied, or 4,888 in all. In 1937 a second questionnaire was sent out to those who had not replied before. The total number of replies, 6,257 (58.7 per cent of those to whom questionnaires were sent), does not represent the total number of graduates, but any survey of this kind must of necessity be based upon the number who reply to the questionnaire.

The proportion of Wellesley College Alumnae married, including graduates from '79 through '34, is 63.7 per cent. This includes graduates less than a year out of college at the time the questionnaire was sent in. Obviously it is misleading to say that 63.7 per cent of Wellesley Alumnae marry, since many graduates of one or two years will undoubtedly not remain single. If the graduates are placed in five-year groups, the figures which result will have some significance. Table I shows that, beginning with the turn of the century, there is a steady increase in the number of graduates who marry, including the graduates out of college from twelve to sixteen years at the time of the study. The smaller proportion of recent graduates who have married is not a real decrease, for among the graduates out of college less than twelve years, there are presumably many who will yet marry. It should be of interest to the eugenists that in 1935, seventy-eight per cent of the graduates out of college from twelve to sixteen years had married.

Number of Children

The eugenist is concerned more specifically with the number of children in the families of these college women. If the number of children (now living, or who lived to the age of 25 years) of Wellesley College graduates is calculated per student, the figure is 1.05 children. The number of children per wife is 1.66. However, if the children of only those mothers who are old enough to have completed their families (Classes '79-'13) are included, there are 2.03 children per wife. If the number of children is calculated per mother the figure is 2.13.

The number of childless marriages in our sample was found to be 22.3 per cent. Huntington and Whitney[1] quote Phillips as reporting that for Harvard graduates from 1851-1900, 23.4 per cent of the marriages were childless. These authors also estimate that 80.8 per cent of the married men in *Who's Who* have children, or that 19.2 per cent of the marriages are childless. Apparently the figure of 22.3 per cent childless marriages for Wellesley College graduates is not unusually high.

Table II gives a general summary of the statistics gathered in this study. No attempt will be made in this paper to compare them with similar figures for the general population. However, it might be pointed out that the divorce rate of 2.1 per cent of alumnae married, and the per cent dead of all children born (3.5 per cent), seem remarkably low. It is possible that some children who died in infancy were not recorded, but since the questionnaire called for these data, and since many alumnae recorded births of children who died on the day of birth, we have reason to believe that our figures are fairly accurate. In any event, such infant mortality would not affect the effective birth-rate of our sample.

It is true that the graduates of Wellesley College are not producing enough children to continue their own lines in future generations—about four children per fertile marriage being necessary to maintain a population. Nevertheless, we cannot insist, at the present time, that this separate college for women is exerting a marked dysgenic effect upon society. Only when a greater array of statistics than are now available make possible valid comparisons between separate colleges for women and co-educational colleges, can we make definite statements as to comparative dysgenic effect upon society of these two types of institutions. The author presents these statistics from one separate college for women with the hope that their publication may encourage similar reports from other institutions.

Literature Cited

1. Huntington, E. and L. F. Whitney. The Builders of America. 1927.

2. Johnson, R. H. and B. Stutzmann. Wellesley's Birth-Rate, *J. Heredity* 6:250-253. 1915.

TABLE I. Statistics for graduates of Wellesley College arranged in five year groups according to the year of graduation.

Classes	Total Reported	Single	Married	Percent Married	Total Children	Children per Wife
79-83	47	17	30	66 %	73	2.43
84-88	100	51	49	49 %	99	2.02
89-93	197	102	95	48 %	180	1.89
94-98	320	147	173	54 %	341	1.97
99-03	332	145	187	56 %	338	1.80
04-08	550	182	368	67 %	791	2.15
09-13	801	252	549	69 %	1136	2.07
14-18	948	225	623	73 %	1229	1.97
19-23	908	200	708	78 %	1302	1.84
24-28	984	312	672	66 %	844	1.25
29-33	873	459	414	47 %	258	.62

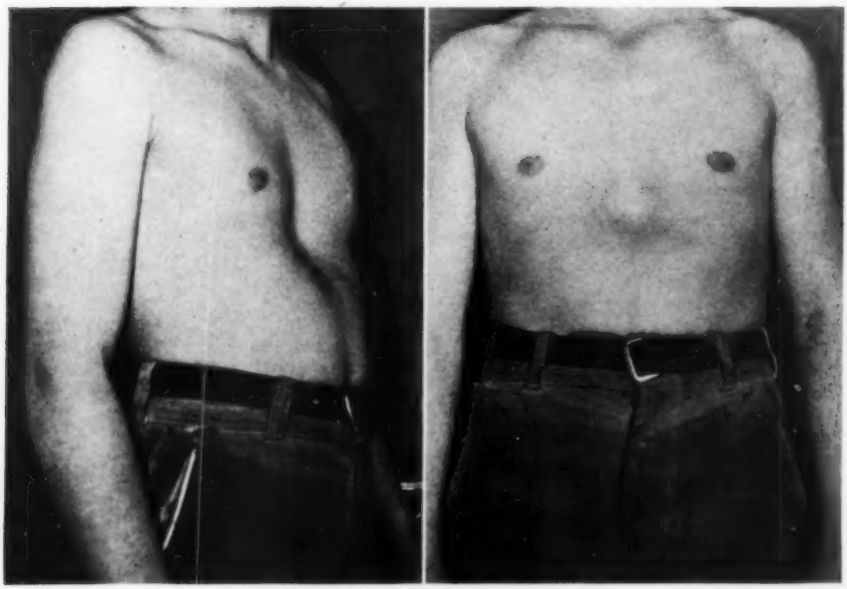
TABLE II. (Right) Summary of Statistics from Questionnaires.

Number to whom questionnaires were sent	10,660
Number reported	6,257
Number single	2,272
Number married	3,985
Per cent married	63.7 %
Total number divorced	84
Per cent divorced	2.1 %
Number remarried after divorce	21
Total children (now living or lived to age of 25 years)	6,600
Children per student	1.05
Children per wife	1.66
Children per wife Classes '79-'13	2.03
Children per mother	2.13
Children dead before 25 years of age	245
Per cent dead of all children born	3.5 %
Number married, no children	890
Per cent childless marriages	22.3 %

THE INHERITANCE OF "HOLLOW CHEST"

"Cobbler's Chest" Due to Heredity—Not An Occupational Deformity

S. EDMUND STODDARD*
Blackfoot, Idaho



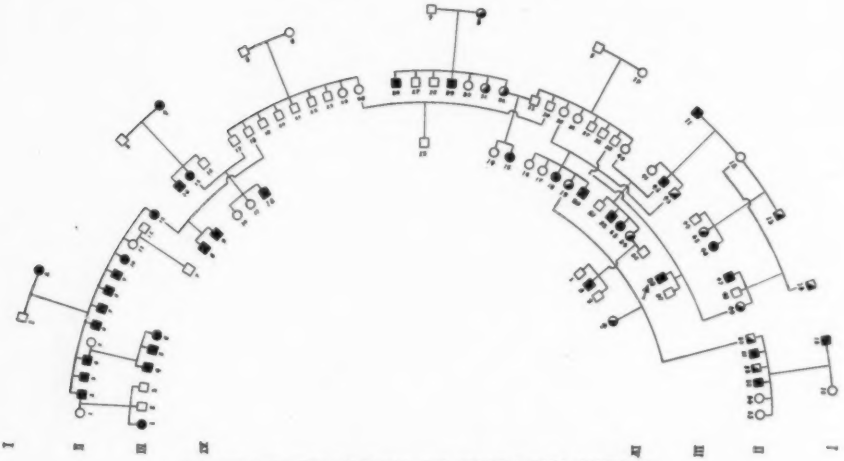
INHERITED "COBBLER'S CHEST"

Figure 4

Front and side views of a young man with the inherited chest depression. The occurrence of this so-called "occupational disease" in several non-cobbling families, raises the question whether it is ever due to following the trade of shoemaker.

DURING the fall of 1935 a student in one of the author's genetic classes called attention to an article in this JOURNAL by L. H. Snyder and G. M. Curtis[a] entitled *An Inherited "Hollow Chest."* This student (III-13 in the pedigree chart—Figure 5 stated he had a number of relatives having a "hollow chest" similar to the anomaly described by Snyder and Curtis. Immediately the author, with the aid of the student, started working on the trait to see whether evidence of a genetic basis for the anomaly could be determined. During the winter of 1935 much of the data presented in Figure 5 were accumulated. The following year the work was continued but not until 1938 was the chart finally completed in its present form. During the last year of work the author had the aid of another student (III-26) who helped in the completion of the chart and kindly submitted himself to a medical examination and to posing for the photographs in Figure 4.

*Contributed by the Zoology Department of the University of Southern California, Los Angeles, California.



FOUR GENERATIONS OF "HOLLOW CHEST"

Figure 5

Relationships of the families carrying the dominant autosomal gene for chest depression. The solid symbols represent individuals with a deep depression; the half solid symbols represent individuals with a slight depression.

In the present study an examination of Figure 5 leads one to the conclusion that the trait is inherited as a dominant autosomal factor. No sign of sex-linkage appears. In the first generation No. 1 does not have the trait but his wife No. 2 does. Of the ten children resulting from this marriage nine have the "hollow chest." In the first generation I-5 and 6 and I-9 and 10 do not have the trait and neither do their children. When these individuals (II, 17-25 and 33-40) marry persons having the trait some of the resulting children are born with it. We may also call attention to I-12, a woman who does not have the trait. She married three times and in each instance to a man having the characteristic. Because of these marriages many of her descendents have the anomaly of "hollow chest." Figure 4 is a photograph of a descendant of this woman.

A medical examination of the propositus was made by A. E. Miller, M.D. The student was found to be in normal health with a pronounced depression in the midline of the chest. The report of Dr. Miller's examination follows:

Physical examination of *D. M.*, male patient, 16 years old.

Head—essentially negative. No bossing of skull bones.
Neck—essentially negative.
Chest:
  Heart—essentially negative. Slight displacement to left side.
  Lungs—essentially negative.
  Deep depression of sternum.
  No evidence of costochondral involvement.
Abdomen—essentially negative.
Genito-urinary—essentially negative.
Neuro-muscular—essentially negative.
Extremities—essentially negative. No bowing or knock knees.
Diagnosis—congenital funnel breast.
  No evidence of rickets or injury.

In studying the literature on the subject we find medical science listing three possibilities that may cause a "hollow" in the chest. These causes are occupational (cobbler's breast), congenital (funnel breast), and rickets. Norris and Landis[2] state there may occasionally be a depression of the sternum extending from the middle of the gladiolus to the ensiform cartilage. They mention that the deformity is usually congenital but may at times be occupational.

Snyder and Curtis report in their study a type of "hollow chest" in which the greatest portion of the depression is on the right side of the midline. Their study resulted in the conclusion that the

trait in no way impairs the health of those affected. They coined the name koilosternia, from the Greek words *koilos,* hollow, and *sternon,* chest. In the present study the main difference is that the depression is in the midline.

Fritz Lenz[1] informs us that J. Paulsen and A. Peiper have presented family studies in which funnel-breast was inherited as a dominant. He states that Peiper is inclined to doubt whether there is such a thing as occupational cobbler's breast.

In making this study several problems have been presented. Why has such a seemingly rare trait appeared in so many different families as shown in the first generation? Perhaps there has been considerable inter-marriage, but this possibility has been checked and thus far does not seem likely. It seems to the author that the anomaly is not so rare as sometimes thought.

Summary

Medical science, then, states there is an anomaly of congenital "hollow chest." Several authors have written of its inheritance. The present study records additional facts as to the inheritance of funnel-breast as a dominant autosomal factor.

Literature Cited

1. Baur, E., E. Fischer, and F. Lenz. Human Heredity. Third Edition. The Macmillan Company, New York. 1931.

2. Norris, G. W., and H. R. M. Landis. Diseases of the Chest and the Principles of Physical Diagnosis. Fourth Edition, Revised. W. B. Saunders Company, Philadelphia and London. 1929.

3. Snyder, L. H., and M. Curtis. An Inherited "Hollow Chest." *Jour. of Hered.* Vol. XXV, No. 11. 1934.

◆

MENTAL DEFECT IN GERMANY

MENTAL deficiency is here* described and discussed from a number of angles, but hereditary diseases and features, problems of sterilization, and of race purification, and the place of scientific medicine in national welfare are kept in the foreground. A number of classifications of developmental deficiency are first presented in terms of pathological anatomy, symptomatic expressions and social adjustments ranging from simple stupidity through to frank idiocy due to gross brain defects. The methods used in investigating heredity in general, and in studying twins in particular are then described and their applications noted in attempting to determine the etiology of several forms of feeblemindedness. What is known of blood relationship, alcoholism and syphilis in parents, which may influence the organization of the fetus, and such conditions as tuberculosis, endocrine disorders, fetal infections and intoxications and birth injuries affecting the development are presented as pre-natal causes of feeblemindedness, while rickets, early brain diseases and blood disorders are classed as post-natal causes. Rather elaborate and sometimes heavy descriptions are made of all bodily systems and physical symptoms associated with mental defect, in all of the numerous different forms. Wherever pathological anatomy and histological alterations form a part of the picture they are analyzed and illustrated in detail.

On the more strictly mental side the author has devoted a section of the monograph to a review of the so-called "normal personality" including the early integration of the personality, difference in sexes, the nature of character and of intelligence with special emphasis on what is interpreted as inherited psychic and intellectual qualities. This concept of a normal personality serves as a basis for comparison and contrast with not only the psychic expressions of feeblemindedness as such, but also with ethi-

**Handbuch Der Erbkrankheiten.* Herausgegeben von Dr. Med. Arthur Gütt: Leiter der Abteilung Volksgesundheit im Reichs—und Preussischen Ministerium des innern Präsident des Preussischen Landesgesundheitsrats. Band I. Der Schwachsinn: von Dr. Med. F. Dubitscher. Pp. 358—45 illustrations. Leipzig: Georg Thieme, 1937.

cal inferiorities characteristic of this group of individuals as seen in their idea formations, asocial and antisocial tendencies, and general life adjustments. A considerable space is devoted to the social importance of developmental deficiency including occupational and educational achievements, reproductive abilities and legal aspects. Genetic precautions and other practical procedures for controlling the spread of feeblemindedness are reviewed. There is a section on intelligence status and special methods for mental testing.

The author's discussion of general sterilization principles and the German law in connection with the sterilization of the mentally deficient is of particular interest. It reveals the facts that the law has not been enforceable in all respects, and that scientific justification has not been forthcoming despite the pronouncements of several race hygienists. Mongolian idiocy, various traumatic states and several exogenous disorders associated with mental deficiency do not lend themselves readily to the concepts of heredity and eugenics. The German ideas on race purification are of interest but they shed very little new light on the problem of mental backwardness.

The work as a whole is hardly up to the older, familiar German type of monographic creation. It brings together a great deal of material on the subject, but many important English and American contributions are not mentioned in the text nor found in the bibliography, although America is comparatively far advanced in dealing with some aspects of these problems.

N. D. C. Lewis
N. Y. Psychiatric Institute

GENETICS OF CONGENITAL HIP DISLOCATION*

SO-CALLED congenital dislocation of the hip usually develops during the first two years of life and sometimes later. The author studied different phases of the abnormality and cases in which it appeared at different ages, taking skiagrams of the hip region. By means of special injections, the cartilage was made visible on the X-ray photographs. In all cases he found a deficiency in the ossification of the cartilage as the cause of the dislocation.

It is well-known that quite often dislocation of the hip does not occur as a single case in a family. To decide the question of heredity, the author examined the families of presumed "isolated" cases. He studied 19 families—in one instance 150 members of one family. The cartilage of the hip joint was X-rayed with the result that in all the families in which only one member with dislocation of the hip was believed to exist, there were several members with a deficiency of ossification. The deficiency is transmitted as a simple irregular dominant, being four times more common than previously considered. Taking into consideration all kinds of disturbances of development in the area of the hip joint, there is no great difference between the male and the female sex, although females seem to be more often afflicted with actual dislocation. The factors of environment have an important bearing only insofar as they act on a joint which is already hereditarily endangered.

In addition to its value for medical knowledge in assessing the cause of the disease, this study is of importance for biology, not only because of the intrinsic interest of the subject, but also because the method applied is both thorough and well-planned. It proves how little one can depend on the statements of laymen where pathological data or dispositions are concerned and it shows a way of avoiding this unreliability. The author does not mention the labour and costs of his method—he was widely assisted by the new German Institutes for family research—but these are certainly justified by the fact that a really reliable result was obtained.

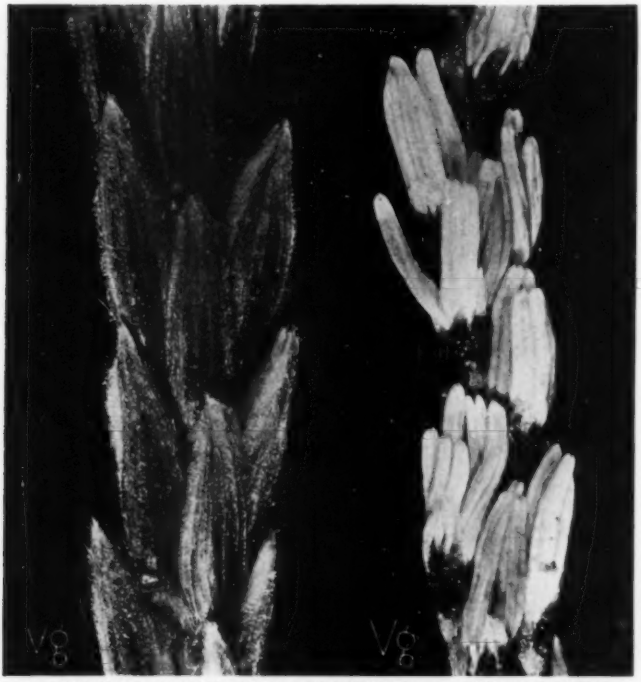
Olga Marum
Bureau of Human Heredity, London

*Faber, Alexander. Untersuchungen ueber die Aetiologie und Pathogenese der angeborenen Hueftverrenkung; eine roentgenologisch-erbklinische Studie. Leipzig (Georg Thieme), 1938, 77 pages, 45 plates; Rm. 7.80.

HERITABLE CHARACTERS IN MAIZE

50—Vestigial Glume*

G. F. SPRAGUE†



EXPOSED ANTHERS OF VESTIGIAL GLUME MAIZE

Figure 6

Enlarged staminate spikelets of corn plants showing the normal (*vg*) and vestigial glumed (*Vg*) character. This reduction in glume size and the exposure of anthers is typical of vestigial glumed plants.

IN 1931 86 plants were grown from a sample of corn received from Kinda Kalonga, Belgian Congo. One plant of this lot had practically no glumes in the tassel. This condition was found to be dominant to normal and has been given the name vestigial glume, with symbol *Vg vg*. Vestigial glume plants are fully viable, of normal size, and compare favorably with their *vg* sibs in yield.

The tassel of a vestigial glume (*Vg*) plant is compared with a normal tassel in Figures 6 and 7. The outer glumes vary considerably in size, ranging from awl-shaped vestiges to approximately one-third normal length. In addition to

*Contribution of the Missouri Agricultural Experiment Station and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture. Missouri Agricultural Experiment Station Journal Series No. 578.

†Associate Agronomist, Division of Cereal Crops and Diseases.

VESTIGIAL TASSEL SMALLER

Figure 7

Tassels from normal (*vg*) and vestigial glumed (*Vg*) corn plants.

being considerably reduced in size, the outer glumes are much more hyaline than glumes of normal tassels. The flowering glumes and palets are also greatly reduced in size. This general reduction in size of all the glumes results in the anthers being almost completely exposed. Under the weather conditions usually prevailing at the time of tassel emergence, the anthers dry up long before dehiscence. Occasionally, however, a plant will shed pollen. In such cases the pollen is fully viable.

Before shelling, ears from *Vg* and *vg* plants are indistinguishable. After shelling, the cobs of the two types are quite distinct, as shown in Figure 8. The thickened basal portion of the outer glume on the cobs of vestigial glume plants is present, although much reduced. The flowering glumes and palet are almost completely suppressed.

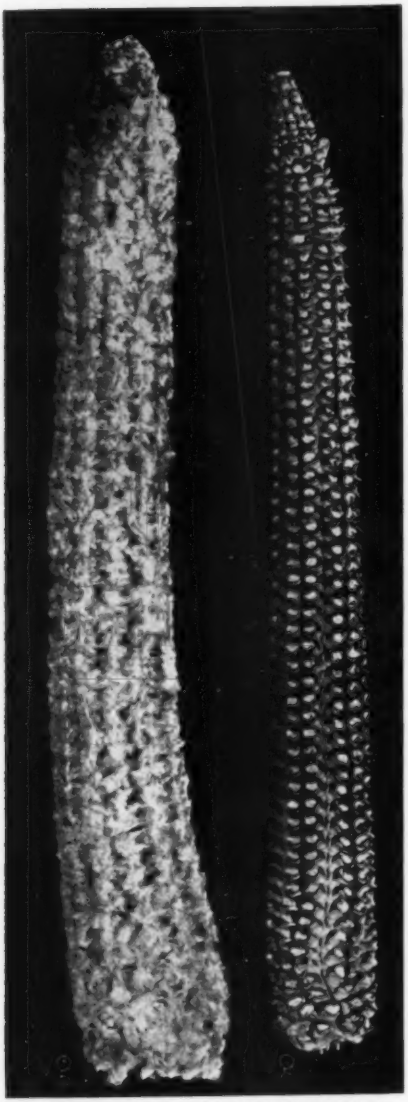
The dominant character *Vg* has been maintained as a heterozygote. The homozygous type *Vg Vg* has never been obtained. No particular effort has been made to produce it due to the difficulty in obtaining pollen. It has been observed that a higher proportion of heterozygotes shed pollen under greenhouse conditions than in the field, and it should be possible to obtain the homozygous dominant form.

In 1937 one plant produced pollen and was used to test male and female transmission of the *Vg* gene. From the cross *Vg vg* × *vg vg*, 124 plants were obtained, of which 62 showed vestigial glume and 62 were normal. The reciprocal cross produced 41 vestigial glume and 39 normal plants. The numbers are not large, but there is no indication of any inequality in the transmission of gametes bearing either the *Vg* or the *vg* genes.

The character vestigial glume was found to belong to the first linkage group. The pertinent data are presented in Tables I and II.

This leads to the following cross-over percentages: *Vg-br*, 3.5; *Vg-bm*$_2$, 42.4; and *br-bm*$_2$, 40.9. This indicates a linear order *Vg-br-bm*$_2$, although little confidence can be placed in records involving two genes so close together as *Vg* and *br*, with a third so far away as *bm*$_2$. The gene f_1 was segregating in the above cross, but conditions were unfavorable for its accurate classification. In similar material grown by Professor R. A. Emerson of Cornell University, a complete classification of the four genes gave the results shown in Table II.

Considering the three genes f_1, *Vg*, and *br*, these data clearly indicate that *Vg* is between f_1 and *br*. The inclusion of *bm*$_2$ in the above classification sug-



NORMAL AND GLUMELESS COBS

Figure 8

Cobs of normal (*vg*) and vestigial glumed (*Vg*) plants. Ears from *Vg* plants are indistinguishable from normal until after the grains have been removed. The virtual absence of glumes may have some commercial value.

gests that f_1 is to the left of *br* with the order f_1-*Vg*-*br*-bm_2. The usual order given for these genes, excluding *Vg*, is *br*-f_1-bm_2. There have been suggestions, however, that this order may not be correct. More backcross data are needed to settle this point, preferably including some gene closer to *br* than bm_2.

The character *Vg* may have some commercial possibilities. In certain types of canned sweet corn, the whole grains are removed from the cob, oftentimes with a portion of the glumes adhering. By introducing the *Vg* gene into sweet corn stocks this undesirable feature could possibly be eliminated. An attempt is being made, by the method of back-pollination, to introduce this dominant gene into Purdue 39, which is the female parent of Golden Cross Bantam. Normally this will require about three generations of back-pollination to Purdue 39, followed by selfing, to fix the *Vg* character. If pollen shedding will permit the maintenance of the homozygote, the commercial plantings of the single cross 39 × 51, using the new line 39, will consist entirely of vestigial glume plants. The back-pollinations necessary to produce this new line are being made by Doctor W. R. Singleton of the Connecticut Agricultural Experiment Station. An important obstacle to the success of such a scheme is that vestigial glume plants shed so poorly that it may be necessary to use some special pollinator or to maintain the gene in a heterozygous condition in the new line 39. In the latter event, only half of the commercial planting would be vestigial glume plants.

TABLE I.* Segregation in the Backcross Progeny *Vg + +* / *+ br* bm_2 × *vg br* bm_2

0	*1*	*2*	*1-2*	*Total*
70-76	1-1	53-50	5-1	
146	2	103	6	257

TABLE II.* Segregation in the Backcross Progeny *+ Vg + +* / f_1 *+ br* bm_2 × f_1 *vg br* bm_2

0	*1*	*2*	*3*	*1-2*	*1-3*	*2-3*	*1-2-3*	*Tot.*
15-22	0-2	1-2	8-8	0-0	0-0	0-3	0-0	
37	2	3	16	0	0	3	0	61

*The seed from which these progenies were grown was supplied by Doctor M. M. Rhoades of the United States Department of Agriculture.

PUDDING PANS HOUSE MURINE "CLIFF DWELLERS"

Figure 9

Photograph of 50 mouse cages, each capable of housing a breeding pair and their young. The bases of the cages are enamelware basins, which are covered by hardware cloth. The tags show the number and classification of the litters and individuals in each cage. This system has been found valuable by the authors in raising large numbers of experimental stock. A slightly larger basin is used for rats.

MOUSE-BREEDING MADE EASY

A. C. Hagedoorn Vorstheuvel LaBrand A. L. Hagedoorn
Institute of Preventive Medicine, Leiden, Holland

THE system of breeding mice in quantity which we want to describe has been tried out for 25 years. We think we are acquainted with most of the different and often very elaborate systems of mouse culture used by geneticists and bacteriologists. Our present system has been evolved by a gradual process of simplification, until we believe we have reached the ultimate in simplicity and utility.

The obvious points of a good mouse cage are suitability for the work in hand, whereby mice are maintained in breeding condition, and large numbers are raised from birth. To the desirable points enumerated, some scientists would like to add two other things, cheapness and simplicity in handling. Many elaborate and expensive cages fulfill these requirements, but at considerable cost in initial expense and upkeep.

Wooden cages are smelly, and mice love to gnaw them. Glass jars and bottles can be easily kept clean, but they are fragile and expensive. Tin, even when painted, rusts. During the war, when the writers were living in California, we were called upon to produce thousands of mice in a short time. The necessity of improvising several hundreds of cages made us look for something cheap and handy. We found that enamelware bowls met this need, and from that time we have used them exclusively in our breeding work.

And So to the Five-and-Ten

Enamelware bowls, or pudding-pans of approximately two quarts content cost about ten cents apiece. They have the advantage of being round. White pans are best because it can be seen whether they are really clean. The bowls are closed by a wire top, for which hardware cloth (four wires to the inch) is used. This wire is galvanized *after* weaving, so that the tops do not ravel.

The wire top must be a square, half an inch smaller than the outside diameter of the rim, and the four corners are bent down sharply, to catch this rim and hold the top on. The corners must be bent just far enough to hold, so the top can be taken off by springing two corners out slightly, as bending the wire ruins it in the end. Some of our covers have seen more than twenty years' continuous service!

Each bowl with its wire top is a complete cage, it contains a handful of sawdust or fine peat moss, a family of mice, *and nothing else*. Gradually we have discarded nesting material, watering bottles and other easily contaminated and hard to clean utensils. Such fixtures may be very nice for the mice, and for the man who gets the job of cleaning them, but from the point of view of a hard-working geneticist, who wants to attend to his own animals, they are a downright bother and they are not necessary.

When mice are kept at a constant temperature of 25 to 28 centigrade nest boxes are superfluous. We lose as few baby mice without them as when we used nest-material.

A "Shot Gun" Ration

Our mice are fed on moist mash, given once daily. We mix equal parts of wheat with a good commercial poultry laying-mash containing cod liver oil, add about ten per cent of dried skimmed milk and enough water to make it wet. We add fresh yeast to the water used, and put the bucket in the mousery over night in a warm spot. After twelve hours the wheat has absorbed part of the water, and the dough has risen and is ready to feed. In feeding we take down every cage with one hand, and with the other hand we place a quantity of mash on top of the wire, sufficient for the family of mice. This daily feeding is our daily inspection; all litters born are marked at

that time with a conspicuous label.

By this system, every mouse in the colony is seen daily. The feeding and inspection takes one of us at most three-quarters of an hour for five hundred cages. Just now our cages are stacked in stacks of three. We would prefer an individual shelf for each row of bowls.

For labelling we use metal-bordered price tags. Every mouse has its tag; litters are noted down on slightly larger labels. The labels and the cage-numbers are hung from corners of the wire by means of strong safety pins. Of course we have a card index with duplicate data.

We use no earmarking. No two mice of the same sex and color are ever put into the same cage after they have been weaned at three weeks. The tag which represents the mouse follows it through life from cage to cage.

Happy Families

We mate our mice in pairs, and leave the father with the litter. Separating pregnant does, with its attendant remating is so much bother that the slight saving of room and feed does not compensate for it. Moreover, we found that we can get more dozens of young from the same number of cages when each female has her own male. As a rule, litters follow each other in quick succession. The maximum number of young we have raised from one pair in a year was 115! Young mice are weaned at three weeks, and most of the young females are ready for breeding at five weeks. Breeding from very young females apparently does not stop their growth, for most of our mice grow to be very large.

Cleaning the cages is a very simple job. One advantage of the absence of nests is that we can go through a section of the colony when cleaning, regardless of the age of the young. We simply transfer every mouse in the cage to a clean bowl, and transfer the top with all its labels to that fresh cage. The dirty bowls are emptied and washed in strong washing soda. As they all fit one into the other (we have two sizes at present) a stack of a hundred bowls can be conveniently boiled in a moderate-sized bucket when necessary.

Between two such thorough cleanings, we often interpolate a "shake-out." Our anthracite stove keeps the whole place dry and none of the litter sticks to the bowls. When shaking out a cage, we tip it upside down and shake out everything, giving a handful of fresh sawdust instead of the dirty litter. We never hesitate to shake out a cage even when it contains a newly born litter. It does not seem to disturb the mice much. Our experience suggests that cannibalism is largely a matter of deficiencies in the diet. One of us can "shake out" a hundred cages per hour; changing the bowls for washed ones takes twice that time. The wire tops are moved along with the mice; they are cleaned only when a family is broken up entirely. The mice eat the food through the wire, and if the correct amount is given, they clean the remains of the meals off the wire entirely. Mice waste a lot of food. The disposal of the wasted food from the cages is quite a problem to research workers on a modest budget. A very good solution is to fatten pigs with it, as we did in our California years.

We breed our rats in similar cages; enamelware dishpans 14 inches wide and 8 inches high, with a square of ⅜ wire on top. We find rats do very well in them, but they need more moisture, and are given a second helping of soaked sugar-beet pulp at night.

From experience we know that every now and then a breeder of mice or rats would like to expand his colony in a hurry, if he could afford to! Our system is a good solution. By paying a visit to a hardware store and to Mr. Woolworth, one can have a hundred extra cages for about fifteen dollars at an hour's notice!

A GENETIC HISTORY OF POLAND-CHINA SWINE*

I—Early Breed History: The "Hot Blood" *Versus* the "Big Type"

JAY L. LUSH and A. L. ANDERSON
Iowa State College

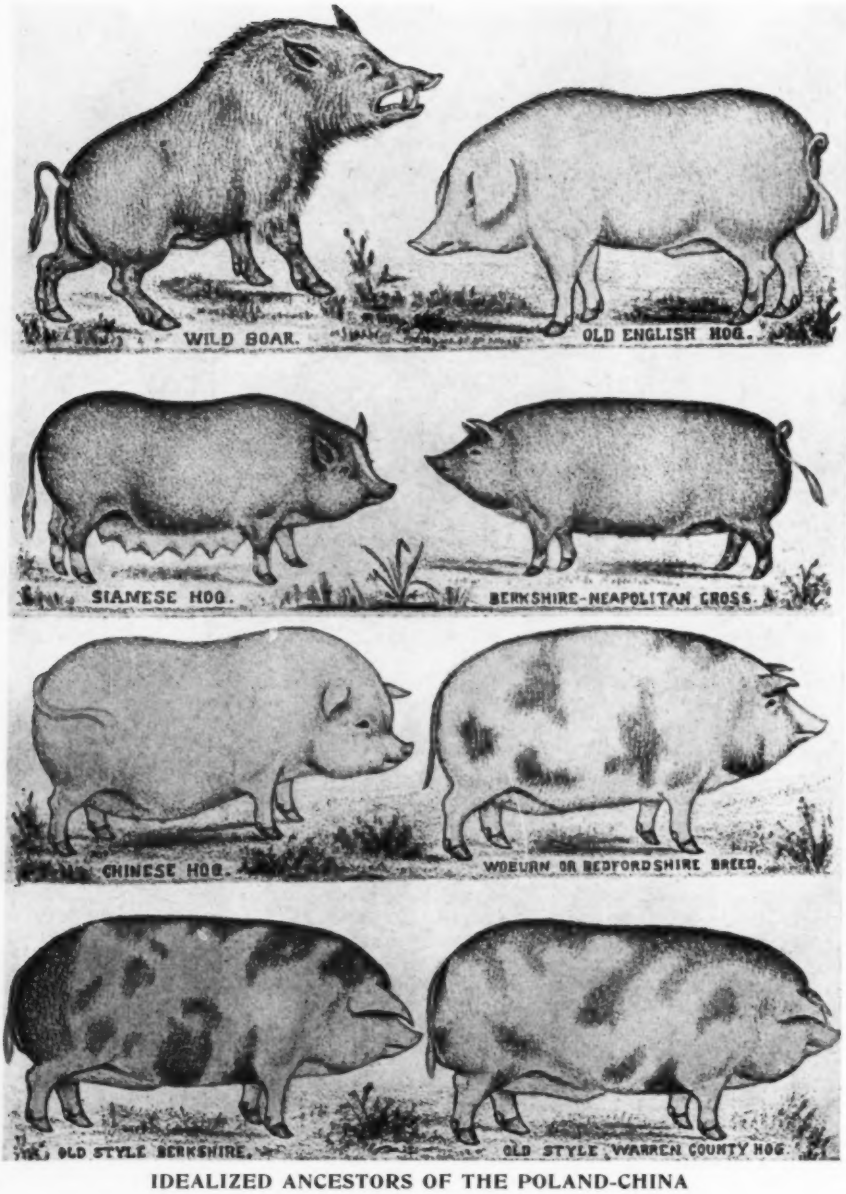
IN spite of its name the Poland-China breed of swine is a peculiarly American contribution to the world's animal husbandry. The breed originated about 1850 but its name was not established definitely until 1872, the first pedigree was not written until 1876 and the first breed association was not organized until 1878. The detailed events of its origin were not thought important enough to record at the time. When the breed had later attained such importance that men thought its history worth writing, many of the facts about how it was produced and why each step was taken had been forgotten forever. Accounts of what happened before 1850 are based on what was remembered by men still active in breeding these hogs in the 1870's, and on scattered and incompletely connected notes preserved from earlier dates.

The breed was formed in response to the economic need of the new cornbelt for pigs which would help market the corn. There was no profitable and readily accessible market for the grain itself and at that time no refrigerated transportation for fresh meat. Pork was more satisfactorily salted, pickled or otherwise preserved by the methods then available than beef and mutton were. As compared with modern conditions there was a very favorable demand for lard. River transportation gave ready access to favorable markets for salt pork, especially fat pork, in the southern states and the West Indies. In recent years those economic conditions have changed again. Mechanical refrigeration has helped make possible a year-round market for fresh pork. The dietary habits of the domestic consumers have changed. Market outlets for lard in foreign countries have been curtailed. These things have modified the goals toward which the breeders are working. Most of them now prefer to describe their ideal as a "meat-type" hog instead of a "lard-type" hog.

The early settlers usually brought their breeding stock with them but they made some importations from distant lands. Groups of animals with different origins were sometimes known locally as "breeds" or races or varieties, but detailed descriptions were not kept of them or of their pedigrees or of how the various races were intermingled. It was not until the 1870's that breed associations were organized for recording the pedigrees of swine, according to the pattern which had already proven successful for cattle breeders. The world's first published herdbook for the pedigrees of swine was that of the Berkshire breed published in America in 1872. The Berkshire originated in England and the American Berkshires were bred purely from imported English stock. Breeds originating in America included, besides the Poland-China and Spotted Poland-China, the Duroc-Jersey, Chester White and (at a somewhat later date) the Hampshire, besides a few others which did not become very numerous. About one-third of the registered boars and sows in the United States in the 1920 and 1930 censuses were Poland-Chinas.

The pre-herdbook history of the Poland-China breed began in southwestern Ohio early in the nineteenth century when "the Warren County Hog" was formed from crossing the native stock

*Journal Paper No. J-565 of the Iowa Agricultural Experiment Station, Ames, Iowa. Parts of this study were made by J. H. Bywaters, O. S. Willham, and H. W. Norton III.



IDEALIZED ANCESTORS OF THE POLAND-CHINA

Figure 10

Artists' conceptions of the diverse races which entered into the melting pot from which the Poland-China breed emerged. (Courtesy of the National Poland-China Record Company.) They came from China indirectly and from Poland not at all, as far as we know.

with "Russian" and with "Byfield" breeds. In 1816 a Shaker settlement at Union Village in Warren County brought a few "Big Chinas" from eastern Pennsylvania and crossed them freely with the native swine. The Warren County Hog was later modified by various crosses with Berkshires (1835) and with Irish Graziers (1839) but no one knows how much each of these breeds was used. Hogs called Bedfords and Neapolitans were also used. Thus the breed emerged from a complex background of crossbreeding, although it is unlikely that all this crossbreeding was undertaken with the deliberate purpose of founding a new pure breed. Probably no outside blood was introduced after 1845, which would be about a dozen generations before the first pedigree was written.[1] In spite of the breed name, it is doubtful that any hogs from Poland entered into the foundation of the breed. That part of the name came from the activities of Asher Asher, a prominent breeder of hogs in southwestern Ohio about 1840. Asher was a native of Poland and some of the hogs from his herd became widely known as Polands. The present name of the breed was established at a meeting of the National Swine Breeders at Indianapolis in 1872. The first herdbook, Volume I of what later came to be known as the *Ohio Poland Record,* was published in 1878. At one time five associations recorded pedigrees for this breed. For the last three decades three such associations have been operating.

The policies of the breed associations have been those customary in the United States. Strictly pure breeding has been required except for a very few years after registration was first begun. An ideal has been defined verbally or by a score-card. During the first few years while the herdbooks were becoming established, there was some inspection and certification of animals as worthy individuals. Since then the responsibility for registering only those purebred Poland-Chinas which conform to the breed standard has rested on the individual breeder. It has not been necessary that animals proposed for registry be formally inspected or approved by breed officials or other breeders. Performance tests have not been prerequisites for registry. Of course the breeder's hogs must suit his customers if he is to be successful in business. In this way the opinions of other breeders do exert some control on his selections, — perhaps about as much as would be exerted by a formal system of inspection?

Noteworthy in Poland-China history have been some extreme changes in ideals, especially in the show-ring expression of them, from "hot bloods" to "big types" and back to "intermediate type" or to "meat type." The other cornbelt breeds of swine have experienced similar but less extreme changes in ideals.*

From the genetic point of view, Poland-China history is especially interesting because of the wide array of types and varieties of swine which went into the melting pot from which the Poland-China breed emerged. Also noteworthy is the time which elapsed — well over a dozen generations — between the last introduction of outside stock and the general recognition that the Poland-China was a definite breed with a degree of purity and fixity of type worth preserving. Unfortunately for genetic analysis, no one preserved the pedigrees of the formative period or described in detail how the foundation stocks were blended. Studies of the recorded pedigrees can shed information on the breeding systems used since pedigree recording be-

*For more details about the changes in ideals in hog breeding, see Davis and Duncan[4] and Vaughan[10] and the early volumes of the herdbooks. The "hot bloods" were small, refined, compact and blocky animals which reached market maturity at light weights and were well suited to market demands at a time when lard was at a premium. They were accused of being slow-growing and low in prolificacy. The "big types" represented a reaction which sometimes went far to the other extremes. They were tall and long and large of bone and higher prolificacy was claimed for them. They grew more rapidly, especially after passing 200 pounds in weight, but often did not reach market maturity (become fat enough to suit the market) until they weighed more than 250 pounds.

"HOT BLOODS" OF THE EIGHTIES

Figure 11

Artists' conceptions of the ideal which the founders of the Poland-China breed had in mind. These drawings are of animals born in 1881 when there was yet almost no animal photography. Doubtless the drawings are exaggerated to emphasize points then thought ideal and important but difficult to attain.

gan, but at that date the formation of the breed was already an accomplished fact.

Scope of the Present Study

The objects of the present study were (1) to find how much inbreeding had been practiced, (2) to learn whether there was any general tendency for the breed to be bred in distinct families or groups with little interchange of breeding stock between them, (3) to find how much influence individual animals had exerted on the breed and (4) to find the average length of time between generations. The methods of investigation were those of Wright and McPhee,[15] slightly modified for using punched card sorting and tabulating equipment.[2]

Studies by these methods have been made of nearly a dozen breeds of livestock, mostly cattle. Besides the studies mentioned* by Willham,[11] studies have been published of Brown Swiss cattle in Switzerland,[9] Telemark cattle in Norway,[3] and Landrace swine in Denmark.[8] A preliminary note concerning the present study of the Poland-China breed was included in an article published in 1932.[6] The only other study of a breed of swine by this method is Rottensten's study of the Landrace in Denmark. In nearly all of these various breeds there has been enough inbreeding to cause a loss of something like .4 to .6 per cent of the existing heterozygosis per generation. The rate was a little lower than this in the later history of the Shorthorn breed and in the one sample of the Brown Swiss breed studied in Switzerland. Only in the early history of the Shorthorn breed, when most of the foundation stock was in the herds of the two Colling brothers, did the rate rise much above this. In nearly every case there has been only a slight (although a statistically significant) tendency for the breed to di-

*For references to these see page 294 of Volume 28 of the JOURNAL OF HEREDITY.

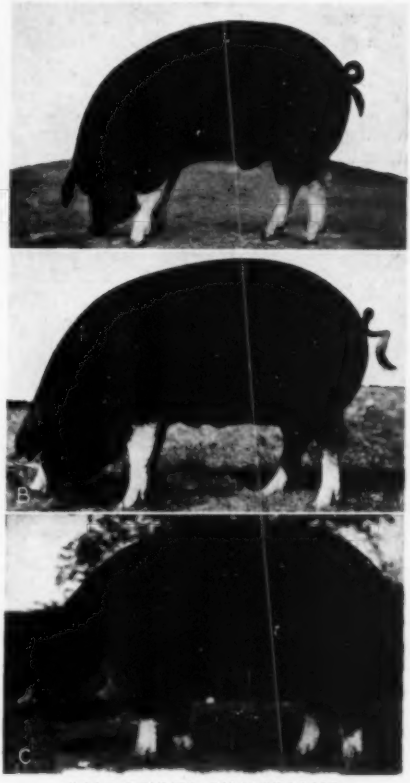
A PROMINENT "HOT BLOOD"

Figure 12

This son of Chief Perfection 2nd sold for a long price in 1902 and was near the ideal which the breeders of the "hot bloods" had in mind in those days. (From a drawing.)

vide into genetically distinct families which, however, are inter-crossed with each other before they drift far apart.

For the present study, a sample of 400 pedigrees was taken from among the registered animals born in each of the four periods studied. These sample pedigrees were chosen at regular intervals in the files or published herdbooks of the American Poland-China Record Association. No attention was paid to the animal's name or to its breeder or to anything about it except its number and birth date. For example if it were necessary to include the pedigrees of one thirty-fourth of the boars from those herdbooks in which most of the animals born in 1900 were recorded, in order to get 200 pedigrees of boars born in 1900, then a list of registry numbers 34 numbers apart was prepared and all the pedigrees with those numbers were used, unless the intended number belonged to an animal born in some other year than 1900. In that case the very next pedigree of a boar born in the right year was used. The pedigrees of 200 sows born in the same year were selected similarly, except that the pedigree numbers were farther apart, since many more sows than boars are registered each year. This procedure was followed rigidly for the samples from 1900, 1910, and 1920, for which printed herdbooks were available. In the 1929 sample (which was the first one studied and which was drawn from



"BIG TYPE" CHAMPIONS

Figure 13

Modern types of Poland-China which won honors at the 1937 National Swine Show. *A* — Grand Champion Poland-China barrow. *B* — "Queen Marie," grand champion sow. *C* — "Top Row," the grand champion boar.

the files of the registry association for the most recent pedigrees then available) half of the animals were born in 1929, a little more than a fourth were born in 1930 and nearly all of the remainder in 1928. Six were born in 1927. The 1920 sample was taken from volumes 85 to 90 and included about two-thirds of one per cent of the boars in those volumes and about one-fourth of one per cent of the sows. The 1910 sample was taken from volumes 58 to 63 and included nearly one per cent of the boars and half of one per cent of the sows. The 1900 sam-

ple was taken from volumes 25 to 29 and included nearly three per cent of the boars and a little more than one per cent of the sows in those volumes.

The different registry associations recognize each other's pedigrees and accept animals whose parents were registered in the other associations. We think that taking our samples from the records of only one association did not materially distort the general picture of breeding systems in use except that our figures may under-estimate the tendency to form separate families as a result of geographic distance. There is some tendency toward a territorial division of registrations but this has many exceptions. Each breeder tends to register his pedigrees in the same association, year after year. Yet in this breed the breeders seem to pay little if any attention to the association in which an animal's pedigree is registered when they are considering buying or selling that animal.

From the sire and from the dam in each pedigree a single line of ancestry was traced at random, (tossing a coin at each step to determine whether the sire or the dam would be traced), as far as that ancestry could be traced in the books of the American Poland-China Record Association. Most of these lines ended in animals registered in the *Ohio Poland-China Record* or in the *Central Poland-China Record* in th 1880's or earlier and could have been traced farther if a complete set of the registry books of those Associations had been available. When a line had been traced as far as possible in the available books, the most remote ancestor found was considered the "foundation animal" and the date of its birth was recorded. Possibly additional interesting facts would have been uncovered if we could have traced the lines to the beginning of the Ohio pedigrees, somewhat as the most interesting part of the early Shorthorn history was found only by tracing the pedigrees to dates earlier than 1820.

We have no way of knowing what proportion of the genes were heterozygous in the average foundation animal, except that it cannot have been as high as one-half, unless (1) the two contrasting alleles in each pair happened to be equally frequent in that population or (2) most allelic series were multiple with no one gene having a frequency much higher than one-half. (For a discussion of the factors which may affect gene frequency, see a recent article by Wright[14]). We think it possible (although perhaps not probable?) that every allelic series was heterozygous in some one or other of the foundation animals but that in most allelic series one allel was so much more abundant than the others that, for each allelic series considered by itself, the proportion of heterozygous animals may have been much less than one-half. Our inbreeding and relationship coefficients and other findings from this study are relative to the condition (whatever that may have been) which prevailed among the group of which these "foundation animals" are a sample. Thus, an inbreeding coefficient of five per cent means that the average number of genes heterozygous in the animals with this coefficient is probably about five per cent less than were heterozygous in the foundation animals. The coefficients of inbreeding and relationship take account only of changes which have probably resulted from the breeding system, i.e. from the laws of chance operating in the segregation and recombination processes in Mendelian inheritance. Changes brought about by mutation are ignored in those coefficients, but mutation is so rare a process that the total amount of change produced by it within a moderate number of generations must have been very small. Changes produced by selection are also ignored. Those may have been considerable on gene frequency (and hence on the population *mean* in many characteristics), but cannot have had much effect on heterozygosis,* especially where selec-

*In a population mating at random the rate of change of heterozygosis (p) as gene frequency (q) changes is $dp \div dq = 2 - 4q$ which is positive when q is less than .5 and negative when q is larger than .5 but is large only when q is near zero or near 1.0. But under those latter conditions selection can change q only slowly. Hence the general inability of selection to produce rapid changes in heterozygosis.

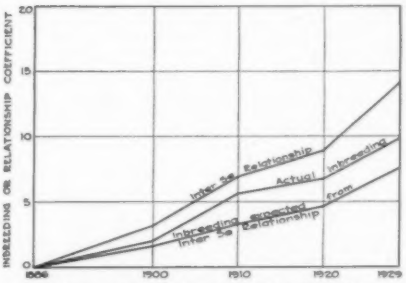


Figure 14

Inbreeding and relationship coefficients in the Poland-China breed.

tion was based on many characteristics, each affected by many genes, and which would have made intense selection for each gene virtually impossible. Though the observed rates of inbreeding may appear feeble, they have probably been the most important force tending to change the heterozygosis of the breed within the space of forty or fifty years covered by this study.

Findings from this Study

The average amounts of inbreeding found for each sample and the amounts expected from the *inter se* relationship coefficients are shown in Table I and Figure 14. The actual amount of inbreeding rises with time in a trend which is unmistakable and fairly steady, but even in 1929 after 44 years of purebreeding the total amount of inbreeding is fairly low. The breeding systems have probably eliminated about ten per cent of the heterozygosis which was in the "foundation animals," whereas a single generation of half brother-sister mating would eliminate more than twelve per cent. At the present rates it will take 50 to 70 years to change homozygosis as much as it would be changed by one generation of half brother-sister mating. This contrast may emphasize how far apart quantitatively are what is called inbreeding here and the "inbreeding" to which many practical animal breeders restrict the term; i.e. matings of brothers with sisters, parents with offspring, grandparents with grandsons or granddaughters or, at most, of uncle with niece or aunt with nephew. About six-tenths of one per cent of the existing heterozygosis has been lost per generation. This is about one-twentieth as fast as heterozygosis would be lost in a one-sire herd and about one-tenth as fast as it would be lost in a herd permanently closed to outside blood but with two equally used sires in service each generation. The rate of inbreeding found would be a powerful force if it occurred in nature over the long stretches of geologic time, but within the active lifetime of an average man would accomplish only a little.

In a random mating population of M equally used males and many more females, the fraction of the existing heterozygosis lost per generation is approximately $\frac{1}{8}M$. Using the observed increase per generation in the inbreeding coefficient and solving for M, we get values of 28 in 1900, 16 in 1910, 21 in 1920, and 20 in 1929. Of course the actual conditions are not as simple or uniform as this. At all times many more than 20 males are actually in use in purebred herds but they are by no means used equally. Fewer than 20 are used so extensively that their descendants continue to be used in large numbers in purebred herds. Far more than 20 are used only a little or have most of their descendants go to grade herds where their genes are lost to the pure breed. Showing, competition, and advertising among breeders constantly cause many breeders to seek sons or grandsons of the few currently famous sires to head their herds in each generation. Yet the most famous sire next year or in the next generation will sometimes not be a son or a grandson or even a close relative of the most famous recent sire. This keeps shifting the emphasis of breeders' selections from one spot to another in the pedigree structure of the breed.

Table 1 and Figure 14 also show the

TABLE I. Inbreeding and Inter Se Relationship Coefficients.

Birth year of		Inbreeding Coefficients			
		Actually found		Total expected from inter se relationship	Inter se relationship coefficient
Sample animals	"Foundation" animals	Total	Per generation		
1900	1886	2.0 ± .5*	.45	1.5	3.2 ± 0.9
1910	1886	5.6 ± .8	.80	3.3	6.4 ± 1.2
1920	1886	6.8 ± .9	.59	6.7	8.9 ± 1.4
1929	1885	9.8 ± 1.	.61	7.4	14.0 ± 1.7

* The figures after the ± signs are standard errors.

inter se relationship and the amounts of inbreeding which would be expected if breeding were random within the limits set by the requirements of breed purity. The observed inbreeding would then result entirely from the fact that all members of the breed are related to each other. If, on the other hand, the breed had been developed as distinct families, each bred within itself and only very rarely having been outcrossed with the other families, the observed inbreeding coefficients would be distinctly higher than those expected from the *inter se* relationship. In all four samples the actual inbreeding is higher than that expected if breeding within the breed had been entirely at random, but it is not much higher. Only in the 1910 sample, when the conflict of ideals between those who favored the "hot bloods" and those who favored the "big type" hog was almost at its peak, did the difference exceed twice its standard error. We conclude that there has been little formation of families or lines any more distinct from each other genetically than human families are in countries of fairly uniform racial composition. Even in a random bred population, there is such a thing as "family" in the sense that full sibs, and to a lesser extent half sibs, cousins, etc., are more like each other than they are like unrelated members of the population; yet these families are inter-connected with each other, some closely and others remotely. Unless the population has been kept in non-interbreeding groups, one can no more divide the entire population into separate families entirely distinct from each other than he can divide a fishing net into separate strands distinct from each other and still retain the net.

Literature Cited

1. Adams, L. Gibson. Ohio breeders dedicate a monument in commemoration of first pedigree. *The Poland-China Jour.*, June 25, page 40. 1922.
2. Baehne, G. W., Editor. Practical applications of the punched card method in colleges and universities. Columbia University Press. (See especially pages 351-353.) 1935.
3. Berge, S. Sewall Wright's innavls- og slektskapskoeffisienter og anvendelse av dem paa telemarkfeet. *Nordisk Jordbrugsforskning*, pages 204-216. 1930.
4. Davis, J. R., and H. S. Duncan. History of the Poland-China breed of swine. 1921.
5. Love, Bert. Camping on the trail of early Poland history. *The Poland-China Jour.*, July 10, page 24. 1920.
6. Lush, Jay L. The amount and kind of inbreeding which has occurred in the development of breeds of livestock. *Proc. Sixth International Genetics Congress* 2: 123-126. 1932.
7. Malin, Donald F. The evolution of breeds. 278 pp. Wallace Publishing Co. 1923.
8. Rottensten, Knud. Indavl og Slaegtskab blandt Svin af den danske Landrace. *Nordisk Jordbrugsforskning*, Nos. 3-4, pages 94-114. 1937.
9. Sciuchetti, A. Ein Beitrag zur Genetischen Analyse der Schweizerischen Braunviehrasse. *Arch. der Julius Klaus-Stiftung*, 10: 85-99. 1935.
10. Vaughan, Henry W. Breeds of livestock in America. R. G. Adams & Co. 1931.
11. Willham, Oliver S. A genetic history of Hereford cattle in the United States. *Jour. of Hered.* 28: 283-294. 1937.
12. Wright, Sewall. Systems of mating. III Assortative mating based on somatic resemblance. *Genetics* 6: 144-161. 1921.
13. ————. Evolution in Mendelian populations. *Genetics* 16: 97-159, especially pages 108-110. 1931.
14. ————. The distribution of gene frequencies in populations. *Proc. Nat. Acad. Sci.* 23: 307-320. 1937.
15. Wright, Sewall, and Hugh C. McPhee. An approximate method of calculating coefficients of inbreeding and relationship from livestock pedigrees. *Jour. Agr. Research* 31: 377-383. 1925.

(To be concluded)

◆

French Population Declines

The population of France showed a sharp decline during the first nine months of 1938 according to official statistics. Deaths exceeded births by 27,365, while in 1937 there were eleven more births than deaths. The number of marriages decreased from 202,811 in the first nine months of 1937 to 200,160 in the same period of 1938. The number of deaths increased from 471,139 in the first nine months of 1937 to 494,107 in the same period of 1938. This increase in mortality is chiefly responsible for the decrease in the natality rate, i. e. relation of births to deaths, because there were 471,150 births in the first nine months of 1937, as compared with 466,742 births in the same period of 1938. — *J. A. M. A.*, April, 1939.

THE NEEDS OF SUPERIOR INDIVIDUALS AS GUIDES TO GROUP ASCENDANCE*

An Experimental Approach to the Problem of "Optimum Environment"

W. Franklin Dove
University of Maine, Orono

THE problem of the adjustment of man and animal to the environment may appear to some as a product of the recent depression. To others, especially biologists, it is recognized as being a problem as ancient as evolution itself. During major economic, financial and political reverses, society retreats from adventures undertaken in the spirit of rank individual freedom to the lock-step of group protection. Like the optimistic amoeba with over-extended pseudopodia who, upon sudden contact with enemy territory, finds safety in an immediate retraction into a rounded and more "integrated" organism, so too a society which has gaily extended and over-expanded into the excesses of prosperity, upon contact with unexpected reverses will retreat with all haste to a group protection in which human society is considered as a whole and is dealt with then, if not at other times, in terms of fundamental needs and adjustments. The final result, both in society and in the organism, is a process of reorganization, reorientation; of sloughing off the unadaptive, inefficient, excessive appendages which have been associated with, or are responsible for, the previous harmful or unevolutionary endeavors.

The history of American civilization represents the rhythmic extension and contraction of a none-too-cautious amoeba in an omnipresent enemy territory. Whereas in times of prosperity we have followed a strongly individualistic and even wasteful economy, nevertheless each depression has brought out the signs of contraction and of return to an emphasis upon the needs of "society-as-a-whole," an activity which pervades the literature of each post-depression period in our history. In brief, the depression of 1837 stimulated the spread of new so-called "communistic" colonies in many parts of the United States. After the depression of 1873 came an interest in social statistics and a move toward labor unification led by the Knights of Labor and the Patrons of Husbandry. The embarrassment of 1907 brought in the governmental move toward conservation of natural and human resources, and stimulated the shift in the Progressive movement toward a State Socialism, as described in Walling's *Progressivism and After* (1914), and brought out such treatises on man and his relation to society-as-a-whole as Thorndike's *The Original Nature of Man* (1913), Parmalee's *The Science of Human Behavior* (1913), Veblen's *The Instinct of Workmanship* (1913), and Wallas's *The Great Society* (1914). Two and a half decades later the depression of 1929 again revived for us the slogans of conservation, public welfare, integration, and adjustment to the environment.

Such, too, are the questions which the biologist must treat not merely in occasional decades but at all times, indeed whenever he attempts to analyze the evolutionary process or the adjustment of living things to their environment. Perhaps the political economist and the sociologist, as well as the biologist, can learn from a study of the organism-as-a-whole:

> Go to the ant, thou sluggard:
> Consider her ways and be wise:
> Which having no guide, overseer, or ruler,
> Provideth her meat in the summer, and
> gathereth her food in the harvest.

*Paper Number 229 from the Biological Laboratory, Maine Agricultural Experiment Station, University of Maine, Orono.

The incongruities that have arisen in past attempts to liken society to an organism, together with the plurality of modifiers and of causes of variations in society which prevent the disclosure of "laws" (Mills and others), have been chiefly responsible for the somewhat widespread attitude that the scientific method cannot be applied to society. During the past ten years the writer has attempted to develop certain of these neglected biological relationships by means of a technique devised to treat experimentally, characteristics which dominate large sectors of so-called "progress" in man, as well as survival and improvement in animals. This common attribute, susceptive to the experimental method, is concerned with one of the strongest biological drives—the urge to get in order to live; the desire to satisfy biological needs or wants.

Obviously, the successful adjustment of man and of animals to their environment not only makes possible the attainment of a certain degree of progress but also favors or protects paravariations and peristatic influences responsible, in part, for the expression of race and breed differences. On the other hand, the failure to adjust is followed, at the level of human society, by the dismality of mass-surveys, educational programs, specialists, government encouragements, and adjustment acts.

An Experimental Technique

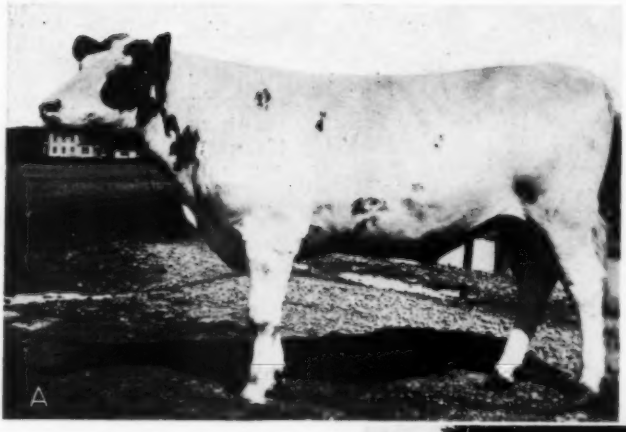
For such an elusive problem we have attempted to devise a scientific technique which includes at least the basic elements of adjustment; elements which may be duplicated or paralleled in both animal organism and in society. With this technique we may hope to subject to repeated controlled experiment factors that have remained too volatile and intangible for social and political analysis.

When one examines the numerous alleged determiners of progress in search for a common denominator he will observe one characteristic as the nexus about which all determinants seem to revolve, and that is the expression and the satisfaction of needs.[1] The needs of the individual, of the strain, of the breed or of the race, either in terms of nutrition or of economics, vary with the physical as well as the social environment.

Furthermore, in terms of needs the genetic deficiency of the Marxian dialectic is appropriately replaced by the biological moving-force of need satisfaction necessary for progress or by its excesses, greed and revolution. Need *versus* greed, then, is the language common to this problem of genetics, nutrition, ecology, sociology and political economy. Upon this characteristic an experimental technique has been constructed.

If the first essential for the experimental analysis of the problem is the acceptance of need satisfaction as one common denominator, the second essential is a technical procedure which duplicates in both organism and in society the relation between the individual and the group, depending on whether individuals act alone, or function in groups, as social aggregates. As we rise in the scale of evolution this interaction between the individual and the group increases in relative importance until, in man, the impact of social and intellectual elements produces an interaction of unlimited moment. Let us retrace our steps slightly down the scale of evolution to birds and to experimental mammals and we still secure strong elements of the reaction, but in a degree of moderation that permits more clearly than in man the observation of the effects of social restriction and freedom as individual and group respond to innate and acquired biological urges. Despite the volatility of some forms of life, in all evolutionary forms we can expect to observe a search for satisfactants as in part an individual and in part a group manisfestation of needs. In this difference between individual and group expression of needs, together with the pliability of the group in assuming the characteristics of certain individuals, we have the key to a controlled phenogenesis—the experimental production of the optimum environment.

Given an experimental technique based upon individual versus group needs the



APPETITE GUIDES THE WAY TO HEALTH
Figure 15

For nearly two years the animal pictured above (*A*) was able to select food for excellent physical condition. With the same opportunities for food-getting, another calf (*B*) was unable to remain thrifty even through one winter. Since he was unable to secure the satisfactants of proper quality and in the proper ratios, he became an early victim of a ricket-like nutritional deficiency disease. The food preference pattern of the superior individual has pragmatic value as an indicator of the pattern of need-satisfactants required for the superiority of the group.

third requirement is the transference of need satisfaction into a measurable characteristic common to both organism and society. In this, we have used growth rate, since accumulation of body weight and accumulation of populations by unit areas are overt expressions of the existence of satisfactants available and of satisfactants secured. Furthermore, growth rate of both organism and of population will mirror the defects, lacks or excesses in the supply of satisfactants and will also indicate the supply necessary for optimum growth within the limits of the immediate supply. Since growth rate is merely the incarnation of satisfactants available and secured, growth rate may not in itself as such distinguish between need and greed. For this distinction other characteristics must be relied upon as correlatives or indices of adjustment in terms of optimum growth, correlatives to growth rate which also bear an interpretation common to organism and to so-

ciety. For these indices we have used longevity, efficiency in the utilization of satisfactants, and consistency.

Since the technique for performing these experiments has been described elsewhere,[1] remarks will be limited to further experimental evidence for the theory together with a terminology to denote the phenomena with which we are concerned.

When the group is treated as an ever-shifting population of individuals rated from lowest to highest in growth rate, the optimum group manifestations of nutritional needs (for growth) are similar to those of the individuals who have been rated during the period of growth to lie between the mean and the maximum for rate of growth. Since this position in the group array represents an ever-shifting series of different individuals, a type is indicated. As the type is integrated from individual (*id*) likeness-differences of all individuals of the group (aggregate), the superior or leader type has been called the aggridant type,[2] an individual type integrated from the group as a whole.

Once the position of the aggridant in relation to other individuals of the group has been determined we can work backwards and calculate the need satisfactants essential for its superiority. When these satisfactants are established in terms of kind, quantity, quality, ratios and rate of acceptance we may be able to modify the group to the extent that the group is phenotypically pliable to respond to the aggridant satisfactants administered. Thus, the aggridant predetermines the conditions necessary for group superiority.

The Aggridant Type as a Guide

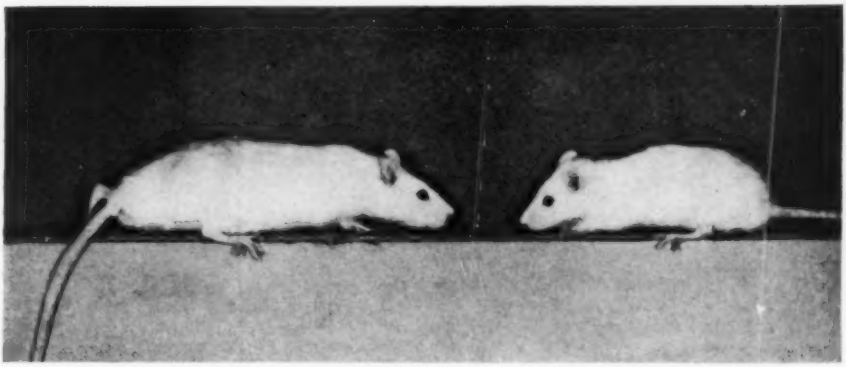
The result of experiments published previously on the nutritional phase of this problem indicated that the aggridant type assumed a growth rate between the mean and the maximum of individual variants. Upon that assumption we have made an extensive search for new foods which would produce superior individuals. As indicated by the desires of the aggridant, seven foods have been made available for selection and from the ratios of the foods preferred by the aggridant type, mixtures of the same foods have been proffered to unselected stock of the same strain.

Under the conditions of the experiment the six-year record maximum weight of a chick at 11 weeks of age has been 1767 grams. With the latest combinations of foods selected by the aggridant type, the maximum weight has been lifted to 2140 grams. In one experiment alone, 12 out of 26 males exceeded the former maximum. The group as a whole exceeded the growth standards for the breed by 24% (for the females) and 30% (for the males) and equalled and exceeded the growth of the much larger breed known as Black Jersey Giant fed on commercial foods usually available and recommended.

These results were secured in a sunless, tungsten-lighted laboratory, and no cod-liver oil or other vitamin supplements were added to the foods. Nevertheless, without these advitants, and even with the excessive growth rate, bone calcification was normal. Ten tibias were analyzed and nine contained more than 48% ash.

Thus, even though the growth rate of the much smaller breed was forced to exceed its usual phenotypic expression by one-fourth to one-third and take upon itself the rate of growth of the giant breed (a breed so much larger as to compare, in the human being, to a different "race") nevertheless, the growth was normal. This accomplishment was made possible through the ability of the aggridant type to select and balance the nutrients, minerals, and vitamins required for its own superiority.

These experiments are factual demonstrations (in so far as they go) of the theory proposed: That the leader type, if integrated from the group, will be able to indicate the needs required not alone for its own superiority but for the superiority of the group as a whole. The superior, aggridant, type represents the optimum final result to be expected from the particular combination of genes and nutrients in the particular environment. If through the expression in terms of needs required for such superiority, the



ABILITY TO CHOOSE PROPER FOOD MAKES A BETTER RAT

Figure 16

Full brothers from the same litter select foods of different kinds and in different ratios, and, as a consequence, one brother is much superior to the other. For 13 successive inbred generations these experimental animals have lived and reproduced their kind on five grain and animal protein foods available in Maine for the animal and human population. These facts indicate that the foods of the State are potentially able to support normal nutrition for a length of time comparable to the 300 years of modern settlement of the State. Lack of accessibility and the resulting poor food habits, economically determined, appear to be the principal cause of present malnutrition. The corrective lies in a food production program based upon the needs of the nutritionally wise and superior individual.

same satisfactants can be supplied to those who, for certain reasons, have failed to express the physiological want or the phenotypic superiority, and superior individuals be made of them, we have in effect the movement of the group-as-a-whole, evolving progressively, ascending ever toward the aggridant type.

Regional Food Production and Human Nutrition

The significance of these experiments for human nutrition and the effect they might well have upon programs of human as well as animal food-production, rests in the nature and type of foods made available for this remarkable growth rate. The seven foods offered for selection were natural foods. Through following the desires of the aggridant type over a period of years, it had become evident that the natural foods are prized above the refined foods.

These foods, and herein lies the contribution of these experiments to human ecology, were also the foods upon which throve the Maine Indian and the Maine pioneer. First of all were the grain foods —wheat, corn, and oats—especially prepared for this experiment by whole grinding in a hammer mill. Hammer ground grain yields an attrition meal, retaining the high mineral and vitamin cortical layers and germ which are removed in the process of manufacturing the "roller" meals and patent flours of today. From the numerous tide mills once scattered along the coast of Maine and from the numerous river water wheels, the pioneers secured the cool, water-ground, whole-grain meal, from corn, wheat, and later, oats. To these whole grains they added white fish — haddock, halibut, hake, and other Maine coast fish—and also salmon and trout. They cooked entire fish heads with the whole ground corn, or, by boiling the corn with milk, produced one of the real delicacies of their diet,[3] over which they poured the unrefined black strap molasses. White fish and milk (dried powdered milk) were, accordingly, two more of the seven foods offered. Finally, another important element of the pioneer diet, eggs, was adapted to these experiments as powdered whole egg. To meet any special need for more phosphorus and calcium than were present in the five

chief foods listed, bone flour and oyster shell flour were also made available. Similarly the Indian and the pioneer increased their supply of calcium and phosphorus from bone marrow and from crushed-bone soup.

The nutritional superiority of natural over refined foods is, of course, common knowledge. Refined foods have been on the nutritionist's black list for decades. These experiments show for the first time that when all the foods made available are in a relatively unrefined state and when they are combined with one another in proper ratios (these ratios having been determined by the aggridant type), they furnish in themselves a completely adequate and superior nutrition. In other words, they make superfluous such advitants as cod-liver oil and similar preventives for malnutrition which now harass the consumer.

In one respect these findings may seem inapplicable to human nutrition, inasmuch as the vitamin *C* requirements of the chick are much lower than those of man. In general, however, our observation that the aggrid avoids refinement in foods and specialization of source in foods corroborates our knowledge of the way in which the Maine pioneer secured vitamin *C* by eating not one but numerous varieties of semi-wild fruits and vegetables such as cranberries, wild strawberries and currants, and some varieties of apples, many of which are now recognized for their high vitamin *C* content. Both the Maine pioneer, so far as we can discover his food habits, and the experimental aggrid react strongly against any form of over-specialization, whether it be confinement to single foods, to a limited diet, or to foods so refined that they no longer retain an optimum allowance of vitamins and minerals.

These experimental results indicate that there is probably some real basis, over and beyond the human tendency to glorify the past, in the many stories of pioneer vigor, and that, to a degree, there is justification for the typical Maine observation that our grandfathers got along without such food fads as minerals and vitamins. Certainly such men as Stephen Wilcox and Major Davis might scorn such modern therapeutic aids:

> The tide mill built by Robert Tidd at North Lubec in 1820 supplied water ground corn and wheat meal for all of Passamaquoddy in the early days. Thirty thousand bushels were ground annually. It is said that Stephen Wilcox, manager of the mill, had the custom of carrying a bag of meal on his shoulder and a firkin of molasses in his hands all the way to his home in the Wilcox Settlement with only one stop—at Sanford Morang's on the West Lubec road. Major Davis was another example of strength: the Major was able to carry 8 bags of meal across the mill, with the bags piled one upon the other on his back and he on all fours.[4]

But the high incidence of vitamin and mineral deficiencies in the present day population of the Maine region[5] shows how far modern food-getting has deviated from what it seems to have been, at least at its best, in pioneer days, apparently because the present food-production program is keyed exclusively to production for exchange without regard for human need.

Above all, these experiments expose the difficulties growing out of the refinement of foods: the change to patent flours, degermed grains, de-boned and stripped meats, a change which has necessitated millions of dollars for nutritional research in order to "discover" the vitamin and mineral deficiencies resulting from such refinement of foods. We are like the broken and separated Humpty Dumpty whose difficulties rested in his separation of parts. All the king's horses (experimental animals used in bio-assay) and all the king's men (nutritionists, biochemists, physiologists) have been unable to put Humpty Dumpty back together again.

In these experiments the aggrid has reconstructed the whole from the pieces. It has gone even further. It has made a ration complete in all its parts, has complemented the attributes of each food with the attributes of all other foods made available. Furthermore it shows pragmatically how the theory of aggrid-ascendance works, how through the integration of individual needs may be determined a superior nutrition whereby the pattern of satisfactants required for

the production of individual superiority may be used as a guide for the production of group superiority. In this respect it demonstrates the physical and the physiological basis of our theory.

Need Satisfaction and Progress

At the beginning we suggested a universal applicability of the laws of need satisfaction to so-called "progress" and, in the end, to racial ascendance. We now might ask: To what extent are the elements responsible for progress and racial ascendance dependent upon need satisfactants, and to what extent may the group-derived aggridant type indicate the pattern, the mode, the manner, or the direction society must adopt in order to make such progress attainable? The answer to this query rests entirely in the extent to which the methods of satisfying various needs have characteristics in common. When the pattern of need-satisfaction is determined or derived from the "superior," that is, from the aggridant type, control over ascendance will depend upon the degree to which the group as a whole may be conditioned to the aggridant type.

The theory of aggridascendance exemplified in the relation between population changes and the presence or absence of satisfactants will be given special attention in a concluding article, at which time the potentiality of the aggridant as a determiner of progress will become increasingly evident.

Literature Cited

1. Dove, W. Franklin. A Study of Individuality in the Nutritive Instincts and of the Causes and Effects of Variations in the Selection of Food. *Amer. Nat* 69:469-544. 1935.

2. ———————. A Study of Individual versus Group Needs as a Theoretical and an Experimental Approach to Aggridascendance. *The Collecting Net* 13:7:151. 27 Aug. 1938. Abstract of paper read before the Summer Meetings of the Genetics Society of America at the Marine Biological Laboratory. (Also in *Genetics* 24:98. 1939.)

The terms *aggrid*, *aggridant*, and *aggridascendance*, although applied to phenomena already described in *Amer. Nat.*, loc. cit., were here used for the first time.

3. Lapham, Wm. B. History of Bethel. p. 50. Augusta, Maine. 1891.

4. This is a paraphrase from the original in the *Lewiston* (Maine) *Herald*. 21 July, 1927.

5. (a) *Maine Agricultural Experiment Station Bulletin 375*:204-208, 1934; (b) *Bulletin 377*:405-407, 1934; and (c) *Bulletin 380*:190-192, 1935.

◆

TOWARD A DEMOCRATIC EUGENICS

A Review of *American Eugenics Today*

Directors of the American Eugenics Society. American Eugenics Today. 10 pp. 10 cents. New York. 1939.

PERHAPS the greatest problem which confronts us at this perplexing time is that of implementing knowledge. Facts are not enough, we must build them into usable and satisfying philosophies.

Disraeli recognized three degrees of falsehood: "lies, damn lies and statistics." The statistics themselves are not to blame. The trouble is with the way they are used:—"Figures don't lie, but liars figure." These two barbed "saws" have enough truth in them to make them hurt and are at the base of this major problem of implementation. We have more *facts* than any other earlier nation, culture or civilization. Many of them have stood at the crossroads of progress or dissolution, the decision has always been made in ignorance and fear. Facts and figures of themselves have no magical properties to avert this disaster. They will no more build themselves into techniques, social systems, or cultures than bricks will array themsleves into cottages or castles without the agency of architects and bricklayers. The long sweep of human culture, and the new techniques of science give us a unique brickyard which has in it the raw materials to build well against the disturbing trends which confront us—economic competition,

war, biological and cultural adverse differentials, et cetera. It rests with us to make our plans so well that we may use this material to build veritable Mansions in the Skies, rather than the Race Track to Ruin, which "Total War" or "Totalitarian Peace" offer as the by no means pleasing alternatives. We have done a fair job of correlating isolated facts into knowledge embracing limited fields of interpretation and utility. It must be regretfully admitted that we have done practically nothing in transmuting such knowledge into that wider, more comprehensive, and more humane correlate, wisdom. Knaves, fools, and liars *figure*,—to the distress of the human race everywhere we have been too easily content to let them do our figuring for us.

Within the last five years one pioneer group has begun to try to think through—carefully, realistically, and humanely—the important facts of psychology, biology, sociology, and economics into a workable and acceptable program of eugenics. Galton, be it recalled, defined eugenics as "a study of the agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally." His immediate followers sometimes took rather naive views of what might and what might not be accomplished in the way of "social control" in a democratic society. Even granting that their biological conclusions were sound (an assumption which would produce violent dissent in some genetic quarters), their reading from history seems to have been to little purpose. If man's long trek through the ages has taught him anything, it is that no class, no caste, and no profession can be trusted with dictatorial control of the destiny of their fellow men. Failure to recognize this elementary fact has been an important factor in a forty-years wandering of eugenics in the wilderness as far as real progress in developing a eugenic philosophy of much use in a democracy is concerned. And yet, if we accept the proposition that some form of democratic control of his political, economic and reproduction activity is essential to man's progress, this is a matter of crucial importance.

About five years ago, a small group of American eugenists courageously attempted to grapple with this problem. Some of the principles they have espoused have been held in certain quarters to amount to a denial of eugenic principles, but such has not been the case. What has been done is simply to give serious thought to that primary element of Galton's definition concerning "agencies under social control." They attempted to appraise realistically what agencies having eugenic significance were under social control in a democracy. They abandoned the naive belief that anything so simple and impractical as "selection" by a committee either on the basis of "superior" or of "inferior" characteristics was likely to be a reasonable or workable proposal among free people. Having realized the futility of such sociological bed-time thinking they set out to find out what existing agencies did deal with social forces having eugenic significance. It immediately became clear that a great variety of human activities did have a definite bearing on the problem of eugenics.

It appeared further that those in charge of these activities (and the basic philosophy motivating many of these activities) were not so much hostile to eugenical principles as they were appallingly ignorant of them. The eugenics group, instead of advocating a philosophy of coercion or of diffuse popular education, wisely embarked on a more direct program to gain contact with these groups—in a series of conferences to discuss with workers in such fields as religion, education, public health nursing, recreation, publicity, the implications of these activities to the biological welfare of our society. A surprising amount of interest in eugenics on the part of those engaged in these "borderline activities" was discovered. The need for thinking along eugenical lines was gladly recognized, for those

engaged in these activities often were faced with situations which demanded a eugenic approach. The eugenists found in turn that they needed the background of real-life interest and understanding which these conferences afforded. Looking at eugenics as something a little forced on humanity from above, may lead us to forget that man is not alone heredity and environment in a purely physical sense. He is also an inheritor of the experiences, the techniques, and the traditions of generations of human beings. Human culture, we are discovering, is a delicate flower which must be carefully and kindly nurtured. It dies easily in an atmosphere of indifference, of fear, intolerance, or hatred.

The Board of the American Eugenics Society has struggled somewhat haltingly forward during the last five years in formulating a philosophy of eugenics which, while recognizing the basic importance of the genetic heritage of the human race, nevertheless does not ignore or belittle the social, the economic, and the environmental factors. Progress reports have been made at irregular intervals by the publication of a series of pamphlets which has charted the way in which this vitally important problem has been approached and thought through,—as far as it has been thought through today. The last of these pamphlets, issued in January, 1939, is entitled "American Eugenics Today." It represents one persistent and most encouraging attempt to get one universe of undigested facts and statistics correlated into a philosophy which transcends mere data. Embracing much knowledge and a composite of many viewpoints, it hopefully perhaps represents the beginnings of wisdom. Such studies are the best antidote we have against the figuring of knaves, fools, and madmen which have given the appeal to facts that alarming odor of dangerous untruth hinted at above. This attempt deserves, therefore, the thoughtful and critical consideration of all who are alive to the changes and the dangers which confront our society today.

Here are brought together a mass of biological and social facts whose interrelationships have too long been neglected. Here lies the key to the development of a citizenry, healthy in body, mind and spirit.

CLAIRETTE P. ARMSTRONG
Children's Court, New York City

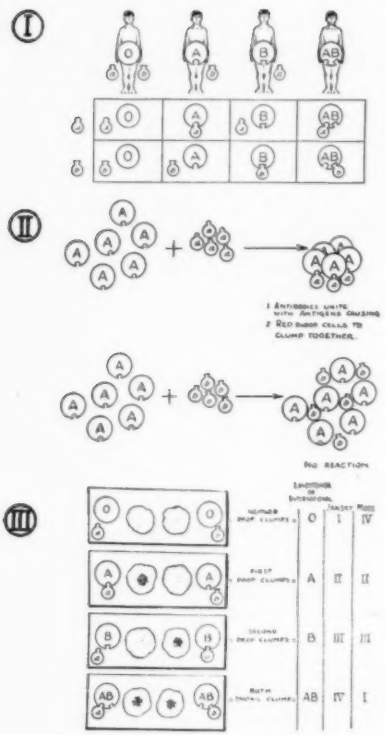
◆

A B C's OF THE *A, B, AB's*

Or the Blood Group Tests Explained

THERE has been a good deal of mystery in the popular mind concerning the blood group tests used in cases of disputed paternity. Perhaps the two facts that the blood group differences are controlled by a trio of allelomorphs, and that a certain amount of laboratory hocus-pocus is necessary to bring to light the differences has resulted in this one gene locus being accorded a unique place in medical jurisprudence. The recent discovery of the M-N blood reaction has added to the number of possible permutations and has increased the percentage of cases in which blood tests can and do give positive diagnosis of non-paternity, for they can never *prove* parentage.

At the present time only two states recognize the blood group tests as admissable as evidence in paternity cases. These states are New York and Wisconsin. In other states the method is occasionally admitted by judicial decision as in a recent case in Ohio. In this case, the expert in blood grouping was a widely known authority in this field, and a research professor of genetics at the Ohio State University. His testimony that the alleged father of the child in question could not possibly have been the father on the basis of the blood group test was ignored by the jury, who found the defendant guilty. The trial judge allowed a plea for a new trial and this was upheld by the Court of Appeals which said in part:



POSSIBLE AND IMPOSSIBLE TYPES OF CHILDREN FROM A-B BLOOD GROUP MATINGS

IV Cross Mother x Putative Father	II Possible Blood Groups of Children				III Impossible Blood Groups of Children			
O x O	O	—	—	—	—	A	B	AB
O x A	O	A	—	—	—	—	B	AB
O x B	O	—	B	—	—	A	—	AB
O x AB	—	A	B	—	O	—	—	AB
A x A	O	A	—	—	—	—	B	AB
A x B	O	A	B	AB	—	—	—	—
A x AB	—	A	B	AB	O	—	—	—
B x B	O	—	B	—	—	A	—	AB
B x AB	—	A	B	AB	O	—	—	—
AB x AB	—	A	B	AB	O	—	—	—

BLOOD GROUPS EXPLAINED

Figure 17

Selections from the nine drawings illustrating "Blood Group Tests as Evidence." I—Chart showing the four "A-B blood types," and their antigen-antibody relations. The antigens are symbolized by notches cut out of the red blood cells; the antibodies by the keyed "a's" and "b's" (small circles). The specificity of antigens and antibodies is diagrammed in II and the microscopical results of mixing the four types of red blood cells with the two antigens is shown in III. IV shows the various possible crosses, and the results in the progeny, of the four *A-B* blood group types.

We are of the opinion that if, as testified by the expert, this science of blood grouping has been so developed and has proved so accurate that it is not only admissible, but of very high value, the woman who has been promiscuous in her relations can no longer make her selection of the male to be charged and secure a verdict against him through the natural sympathy aroused in a jury.

The blood grouping is the fingerprint of blood, although there is a pronounced difference in that identification is made by fingerprints, because no two persons in the world have finger markings so nearly alike that the difference can not be detected, while in the blood test it is asserted that all living humans have blood that falls within twelve different groups. The purpose of the test is not to determine who may be the father, but who can not be the father, and is therefore to be excluded. (Twelve groups include *M-N*.—Ed.)

Thus even in states where the test is not recognized by specific legal enactment its acceptance as in this case establishes a precedent which facilitates admission of such evidence in later cases.

As a matter of fact, the genetic background of the blood group test is simple enough, and the laboratory technique necessary to perform the test does not involve any great complexity. Its principles are applied as a necessary precaution prior to every blood transfusion, because the same cross agglutination of incompatible bloods which would be liable to result in the death of the patient, were they mixed in his veins, reveal, when tested against a known sample of the antigen, the blood group of the putative parents of the child. The genetic and immunological bases of the tests have been made available in booklet recently published by Robert C. True of the Massachusetts Society for the Prevention of Cruelty to Children. The text and illustrations are the work of Dr. Clyde E. Keeler who studies mammalian genetics at the Harvard Medical School and whose delightful excursions into biological art are well known to readers of this Journal. These two activities have been fruitfully combined in the booklet in question, in a form to enable any intelligent person to form a clear idea as to what happens when incompatible bloods are mixed, as to how the reactions observed under a microscope are interpreted, and as to the genetic basis of this

and the conclusions which may be drawn from it. A few of the drawings are reproduced herewith. As a matter of fact, there are a number of other genetic characters which could be used as well as the blood groups. Thus when both parents manifest the recessive allelomorph of any genetic character, the child must manifest it too. If the putative parents are concordant with respect to such a character and the child is not, there is something wrong (barring mutations) with the allegations of paternity. At the present time it is essential that for legal purposes the evidence of our senses shall be buttressed by laboratory techniques. The time may eventually arrive when the evidence of genetical experts, even when not fortified by test-tubes and microscopes, will be accepted in a Court of Law.

The book was sponsored by Robert C. True of the Society for Prevention of Cruelty to Children because, to quote the Editor's note:

> During my ten years of association with the Massachusetts Society for Prevention of Cruelty to Children, I have had many a situation referred to me concerning illegitimacy cases. I have been particularly impressed with the number of cases in which lives have been ruined by false accusations of paternity, the misrepresentation being later admitted by the mothers of children in question.
>
> In seeking justice for the children, I have had no desire to have convicted persons falsely accused of paternity, or persons who had no way of proving that they were not guilty. The Courts, nevertheless, must judge only on the evidence that is placed before them.

The test has perhaps been overburdened with claims of mysteriously occult powers necessary to evaluate it properly. This booklet should be very helpful in banishing this superstitution. Perhaps it leans a bit the other way in giving the idea that everything is so A-B-C simple that expert manipulation and interpretation is altogether unnecessary. That would be unfortunate, because any refined biological test must be done with great care and with full knowledge of the possibilities of error. The results must be interpreted by a person whose experience qualifies him to evaluate the facts before a court of law. In every university and medical school of the country we would expect to find people who are adequately qualified to serve in this capacity. Dr. Keeler is quite right in holding that exorbitant fees for the services of experts brought from a great distance are not essential to assure that justice will be done so far as blood groups make this possible.

Perhaps in actual practice, the most valuable outcome of the publication of such a booklet will be in making it possible to dispose of unfounded charges before they reach the courts. Where it is known in advance that the testimony of the blood groups will exonerate an accused person in a paternity case, the urge to make false accusations will be greatly weakened.

The booklet should do much good in making available in the simplest form the basic information about blood group immunology and genetics. Both in the field of legal jurisprudence and of genetic education it is an excellent and a very useful undertaking.

R. C.

✦

A DIONNE SUGAR-COATING FOR PARENT EDUCATION

EVERYONE loves the quintuplets; and everyone wants to read about them, even among those of the adult laity who might be designated as non-readers. I have had to watch my copy closely to see that it is loaned fairly, and in turn, to each person who early got on the waiting list of would-be borrowers. Reading interest in *The Five Sisters** is thus assured even before one picks up the book which tells all about the five little Dionnes and how they grew under the educational supervision of Dr. Blatz and his staff of psychologists and nursery teachers.

The breath which the public held

*Blatz, W. E. M.A., M.B., Ph.D. *The Five Sisters: A Study in Child Psychology.* 209 pp. $2.50. Morrow, New York. 1938.

bated during its watch over the early struggles to maintain life in the five little bodies is now expanded into exclamations of delight at the grace and loveliness of the quintuplets. The social experiment at Callender, Ontario, is a test not only of how to rear bigger and better quintuplets but of how to bring home to parents the world over, not excluding Mr. and Mrs. Dionne, the fact that scientific care, mixed with affection not necessarily born of the womb, will do far more to develop healthy, happy and lovable children than will any amount of natural affection, coupled with the insight supposed to accrue to the untutored parent by some sort of instinct.

This book may be the sugar-coating on the parent-training pill, which will lead to larger ingestion. As you read through its pages, you wonder whether Dr. Blatz's primary purpose was to tell the world about Yvonne, Marie, Cecile, Annette and Emile, or to administer a good dose of child psychology to hesitant or protesting parents. At any rate, the decoy of the many smiling faces scattered so liberally throughout the text will serve to lure the reader into pages of theoretical discussion on the discipline of freedom, the prevention of child tantrums and phobias, the cultural pressures which mold personality, especially during the first five years of life, the role of heredity especially for physical traits, the individuality of the human self, even though born of a single zygote which split five ways.

The chapter on the evidence for the identicalness of the quintuplets will interest the biologist, the discussion of mental and personality ratings will be meaningful to the professional psychologist, the diagrams of the buildings and grounds at Dafoe Hospital together with the routine records and schedules of training will appeal to nursey-school teachers, though not without significance to parents enrolled in child-study groups. But the story of the children themselves will reach out to all.

Marie, the smallest of the five, is frailest in her co-ordinative powers. Yvonne is most advanced, with the other three holding intermediate places. This slight unevenness of development presents a basis for differentiation of experience and development of personality, for each girl will always react to the traits which are developing in the other four. They start a tricycle parade around their play arena, with Marie soon bringing up the rear. As the race progresses, however, Marie suddenly finds herself at the head of the procession, unmindful of the fact that she has missed a lap. She strives valiantly to hold her lead, but is quickly outdistanced by her studier and speedier sisters.

Will this unevenness of abilities continue, or will Marie eventually catch up? If and when she does overtake her sisters, will her achievements then serve to erase the earlier feelings of inferiority which are bound to be experienced? Dr. Blatz does not pose this question, but I am sure he is aware of it. Even among five identicals, there are problems to be faced on personality adjustment which come within the range of every home. There are many other problems peculiar to a quintuplet situation alone, which ordinary parents are spared.

The world will continue to watch the five sisters. People will continue to hazard their guesses, to offer advise, to present criticism or praise, to draw their own deductions as to the value of their educational regime. A conscientious reading of this and other reports from the University of Toronto psychologists will win many converts at the present time. The final answer will come when the girls are "on their own." But the degree to which they have established their maturity at the four-year level indicates that as adults they will attain a social and emotional maturity that is rare among the generations which have preceded them.

GLADYS C. SCHWESINGER
Museum of Natural History, New York

CHROMOSOMES OF THE DIAPENSIACEAE

A Cytological Approach to a Phylogenetic Problem

J. T. Baldwin, Jr.
Bailey Hortorium and Department of Botany, Cornell University

THE Diapensiaceae, of which the best known American representative is Galax, offer an alluring field for a cyto-genetic approach to problems of phylogeny and taxonomy. The family comprises thirteen described species in six genera; they constitute the Diapensiales, the first order of the Metachlamydeae.[2] It would appear from the *Index Kewensis* that the number of species is slightly more than thirteen. All of them are perennial. One of the species (*Diapensia lapponica*) is arctic-circumpolar; the others are east North American or east Asian. Thus, the family, and particularly two of its genera, *Diapensia* and *Shortia*, has the sort of distribution recognized by Gray[5] whereby plants of close relationship are often common to eastern North America and eastern Asia, whether or not they occur in northern Europe and northern Asia. Pursh[12] earlier had compared North American plants with those of northern Asia, "to some of which they have great affinity, and others are common to both continents." Glaciation was an important factor in the dispersal of such groups. The Diapensiaceae are considered an old family.

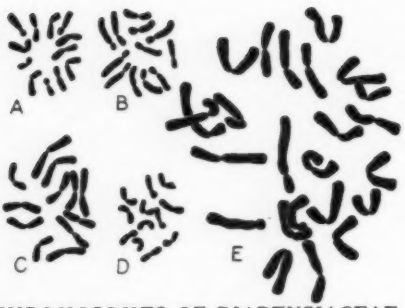
The relations of the Diapensiaceae with various other families have been remarked by a number of writers, among them Gray,[6] Samuelsson,[14] and Diels[1]; those different families are often placed far apart in systems of classification. That any given group of plants has recognizable affinities with many other groups which themselves may not evidence relationship is not surprising: phylogeny is a process reticular as well as dendritic. Discoveries of unexpected kinships are accordingly to be expected. Families, genera, and species are convenient categories in which to classify incidental expressions, varying in magnitude and duration, of fundamental tendencies in genic and chromosomal evolution. Those tendencies have points of origin and points of fusion, and this is an important reason why systematists have trouble with their systems. The effort of Hayata[9] to formulate a system of classification founded on a concept of complex and dynamic inter-relationships was an attempt to bring taxonomy into harmony with findings in cytology and genetics.

Chromosome counts have been made for one species in each of five genera of the family, the observations being on somatic tissues: root, leaf, and stem. Specimens of these plants are, or will be, in the herbarium of the Bailey Hortorium. Because the roots are fine and fibrous, and mitoses few, leaf and stem tissues were more often used. The method was: to kill the material for five minutes to twelve hours in Carnoy's solution (3 parts chloroform, 2 parts absolute alcohol, and 1 part glacial acetic acid); to transfer for two or three minutes to a solution of 1 part 95 per cent alcohol and 1 part concentrated hydrochloric acid; to place the material back into Carnoy's for at least five minutes, and to smear in iron aceto-carmine. This procedure is a modification of Warmke's[18] technique.

The following division of the family into tribes is that of Gray.[7] Similar division is given by Engler and Diels.[2]

Tribe I. Diapensieae

Pyxidanthera Michx. The genus has two species: *P. barbulata* Michx. in the sandy pine barrens of the coastal plain from New Jersey to South Carolina and *P. brevifolia* Wells in the sandhills of the interior of North Carolina. Engler and Diels mention only Michaux's species. Plants of *P. barbulata* from New Jersey (collected by W. C. Wilson) and from



CHROMOSOMES OF DIAPENSIACEAE
Figure 18

A—Pyxidanthera, B—Diapensia, C—Shortia, D—Schizocodon; all metaphases, $2n=12$. *E—Galax*, prophase, $2n=24$. *A, B, D* × 1700. *C, E* × 2500.

North Carolina (collected by G. Latta Clement) have 12 somatic chromosomes. A metaphase from a young leaf of the New Jersey material is shown in Figure 18*A*.

Diapensia L. As revised by Evans,[8] the genus consists of four species separable on morphological and distributional bases into two sections: Lapponiceae, one species, *D. lapponica*, extending from eastern North America through northern Europe to northern Asia and Japan; and Himalaicae, three species restricted to the Sino-Himalayan mountains. The chromosome number of only *D. lapponica* is known; both of the varieties accepted by Evans have been counted. *D. lapponica* var. *obovata* Schm. occurs in northern Asia and Japan; its range is entirely distinct from that of var. *genuina* Busch. Samuelsson[14] found $n = 6$, $2n = 12$, in the species as occurring in Sweden. Hagerup[5] found the same gametic number in material from Greenland. Plants (collected by Max Nagler) from Mount Marcy in New York have 12 somatic chromosomes (Figure 18*B*, from a leaf). Sugiura[16] reported an *n*-number of 6 for *D. obovata*, this being *D. lapponica* var. *obovata*. It thus appears that the species throughout its range and in both its varieties has a constant number of chromosomes. It is apparent, therefore, that no chromosome-number difference is associated with the more vigorous growth reported for var. *obovata*.

Shortia Torrey and Gray. House[10] pointed out that this generic name "cannot be maintained, as there exists a previously named genus *Shortia*, published by Rafinesque." House then designated the genus *Sherwoodia*. But it has been proposed that *Shortia* be conserved (International Rules, 1935), so that name is used here. The genus needs taxonomic revision. According to Engler and Diels, *Shortia* consists of four species, three in Asia and one in the Carolinas of North America. The extremely localized occurrence of the American species, *S. galacifolia*, is attributed by Ross[12] to a lack of means for seed dispersal: the seed germinate in the ovary which then decays. The species has 12 somatic chromosomes. Plants at The Blandy Experimental Farm in Virginia (Figure 18*C*, from a root) and in the greenhouses of Cornell University were counted.

Schizocodon Sieb. and Zucc. Two Japanese species are considered to constitute the genus. *S. soldanelloides* Sieb. and Zucc (not seen in flower; raised from seed by Max Nagler) has a $2n$-number of 12 (Figure 18*D*, from a leaf).

Berneuxia Decne. This is a monotypic genus from China. It has not been available for cytological study.

Tribe II. Galacineae

Galax L. The genus is monotypic: *G. aphylla* L. It occurs in the open woods of the Piedmont region and the Appalachian plateau from Georgia and Alabama to West Virginia and extends into the coastal plain in North Carolina and Virginia.[15] It has become somewhat naturalized in Massachusetts.[17] It apparently is more amenable to cultivation than are others of the Diapensiaceae now grown in America (see Frye[4]). Perhaps this greater ecological adaptability on the part of *Galax* results from the polyploid nature of the species: plants at The Blandy Experimental Farm have 24 somatic chromosomes. Counts were made from root (Figure 18*E*, prophase) and stem preparations.

Chromosome Differences

Differences in chromosome size exist within each of the five specific complements studied. But the size-range for the chromosomes of any of the five species is about that of the family. Figure 18 does not give this impression. The drawings are from different tissues and of different phases of the mitotic cycle, and they are drawn at two different magnifications from smears. Furthermore, the several plants were growing in soils varying in composition. All of these factors condition the real or the optical size of chromosomes. Constrictions are clearly evident. In *Diapensia lapponica* var. *genuina* (Figure 18*B*) all of the constrictions are submedian. In *Shortia galacifolia* (Figure 18*C*) all of the constrictions are about median. The other three species have chromosomes medially or submedially constricted.

Polyploidy in the Diapensiaceae coincides with a taxonomic division of tribal rank. The fact is interesting. It also is of interest that the only polyploid species

(*Galax aphylla*) known for the family has the most southern distribution in North America. In contrast, *Diapensia lapponica,* with half as many chromosomes, is arctic-alpine. Low temperature has been inferred to be less limiting as a factor in the distribution of polyploids than in the distribution of diploids. Polyploids supposedly have a higher adaptation value. They are considered able to withstand adverse conditions better, but an environment adverse for one plant group may be favorable for another. Polyploids in some families may tend to be northern in their occurrence and, in other families, southern. Occasionally, since distribution is also limited by other factors, no correlation of polyploidy with temperature may exist. The various hypotheses concerning the cyto-ecological relations of plants should be tested experimentally. Valuable facts might be revealed by determining the lethal freezing points for diploid and polyploid races within a number of species far apart taxonomically. It should also be of interest to compare induced polyploids with polyploids found in nature.

Literature Cited

1. Diels, L. Diapensiaceen-Studien. *Bot. Jahrb.* 50:304-330. 1914.
2. Engler, A. and Diels, L. Syllabus der Pflanzenfamilien. Borntraeger. Berlin. 1936.
3. Evans, W. E. A Revision of the Genus *Diapensia,* etc. *Notes, R. B. G., Edin.* 74:209-236. 1927.
4. Frye, E. M. American Diapensiaceae. *New Flora and Silva* 6:192-193. 1934.
5. Gray, Asa. Diagnostic Characters of New Species of Phaenogamous Plants, Collected in Japan, etc. *Mem. Amer. Acad. Arts and Sciences* 6 (New Series): 377-452. 1858.
6. ————————. Reconstruction of the order Diapensiaceae. *Proc. Amer. Acad. Arts and Sciences* 8:243-247. 1873.
7. ————————. Sur le *Shortia galacifolia* et Revision des Diapensiacées. *Ann. Sc. Nat.* 7 (Sér. 6): 173-179. 1878.
8. Hagerup, O. Morphological and Cytological Studies of Bicornes. *Dansk Bot. Arkiv* 6:1-26. 1928.
9. Hayata, B. The Natural Classification of Plants according to the Dynamic System. *Icones Plant. Formosanarum* 10: 97-234. 1921.
10. House, H. D. The Genus *Shortia. Torreya* 7:233-234. 1907.
11. International Rules of Botanical Nomenclature. Gustav Fischer. Jena. 1935.
12. Pursh, F. *Flora Americae Septentrionals, I.* London. White, Cochrane, and Co. 1814.
13. Ross, M. N. Seed Reproduction of *Shortia galacifolia. Jour. N. Y. Bot. Gard.* 37:208-211. 1936.
14. Samuelsson, G. Studien über die Entwicklungsgeschichte der Blüten einger Bicornes-Typen. *Sv. Bot. Tids.* 7:97-188. 1913.
15. Small, J. K. Manual of the Southeastern Flora. Published by the author. New York. 1933.
16. Sugiura, T. A List of Chromosome Numbers in Angiospermous Plants, III. *Bot. Mag.* 51:425-426. 1937.
17. Ward, M. E. *Galax aphylla* Introduced in Massachusetts. *Rhodora* 21:24. 1919.
18. Warmke, H. E. A Permanent Root Tip Smear Method. *Stain Tech.* 10:101-103. 1935.

◆

POULTRY HUSBANDRY

THIS new edition of the author's popular text* comprises 548 pages grouped into 13 chapters as compared with 639 pages and 33 chapters in the 1930 edition. In spite of this reduction in printed material the book contains more "meat" and less "water" than formerly. Much space is saved by omitting to cite individual references and by printing selected literature lists, contrary to the practice followed in the first edition. Because of this the book becomes more of a text for the student and less of a reference source for the specialized investigator.

The eight years between editions have witnessed a tremendous growth of poultry science. More knowledge concerning detailed fundamental processes underlying animal physiology has accumulated in the last decade than in any similar period of recorded history and more light has been shed on the coordination of physiological systems through the endocrines in the same decade than in all previous his-

*Jull, Morley A., *Poultry Husbandry.* 2nd ed., pp. VIII + 548. McGraw-Hill, New York. 1938.

tory. Jull's first edition was prepared and published just as the intense research activity which yielded this knowledge was beginning. Consequently a couple of years after its publication the first edition was already largely out of date as a reference text for the specialized researcher and because of its lengthy list of literature citations without critical appraisal of the often contradictory findings of different workers, the book was confusing to the student. It is now clear that a book for beginning students and studious poultrymen must differ from one which is intended as an authoritative text for the investigator. Specialization in poultry research has reached the point where any detailed authoritative survey of the latter sort can only result through the effort of a group of specialist authors under the coordinated guidance of a general editor. Scientific texts of this sort are becoming more and more frequent and scientific knowledge concerning the biology of the fowl is now specialized and detailed enough to require such a text. The book under review is an excellent text for the student. It is an authoritative summary of exising knowledge and should serve to provide the beginner with a vision of the vastness of existing knowledge and with a stimulus and an incentive for more advanced study.

The book starts with a description of the various breeds including notes of the origin of the domestic fowl. This is followed by a chapter entitled "The Biology of the Chicken" which, in very abbreviated form runs the gamut of structural and functional anatomy and ends with an exposition of the genetic basis of reproduction, emphasizing sex determination and sex-linkage. The principles of respiration, digestion, reproduction and sex differentiation, hormone regulation, physiology of feather formation (no mention of coloration) and egg formation are all mentioned in these 25 pages. In short, this chapter deals with the sort of material of which a specialized text could be made. It is the only pure science chapter in the book and this reviewer finds himself wishing that it had been elaborated just a bit more to give the student a larger vision of the field of research.

From this point on the book deals with the practical problems of poultry raising in chronological order, e. g., breeding, incubation, rearing, housing and yarding, feeding and marketing. Each of these are dealt with first from the standpoint of practice. In this way the subjects are dealt with first from the standpoint of what is known and second how best to put this into practice. Some of the subjects emphasized in this edition and which received little or no mention in the former are, in connection with breeding work,—selection for early feathering, growth rate, meat type, viability and disease resistance and the progeny test of males, especially in breeding for egg production. Second, in nutrition, the vitamin *G* complex, especially the effects of the riboflavin factor on growth rate and hatchability, the antihemorrhagic vitamin *K*, proteins, phosphorus, minerals, et cetera. There is an up-to-date chapter on "Disease Prevention," an aptly chosen title. The section on housing shows little change other than slightly more emphasis on ventilation. A section on laying cages has been added. Considerable research on incubation has been carried on since the first edition and much precise knowledge gained which is listed in the book. Curiously enough, this results in little change in incubation practices.

The book contains two chapters on the marketing of eggs and poultry meat which emphasizes quality and gives detailed descriptions of methods of processing and preserving. The book ends with a chapter on the economics of production and marketing. A list of Agriculutral Colleges and Experimental Stations in the United States and Canada and an excellent detailed index round out what is without question the most up-to-date poultry text book yet published.

S. S. Munro

Central Experimental Farm, Ottawa, Canada

DIRECT CONTROL OF AVIAN COLOR PATTERN BY THE PIGMENTOBLASTS

C. H. DANFORTH
Department of Anatomy, Stanford University

THE color of a feather is determined largely by minute pigment granules that are developed and transferred to their definite position by amoeboid pigmentoblasts, which gradually degenerate as the feather matures. It has been the general assumption that the pigmentoblasts, and the patterns which their granules produce, are directly controlled by surrounding tissues, but recent evidence indicates that the pigmentoblasts themselves directly determine not only pigment production but pattern organization as well. If this proves to be true, we shall have a more precise knowledge of the exact cells through which the genes for color and pattern operate, and a more satisfactory basis for interpreting such probable non-disjunctional mosaics as those reported by Asmundson,[1] Munro,[10] and others.

When the first successful skin-grafts between different breeds of fowl were made a dozen years ago,[7] a few individual feathers were observed to show, in mosaic pattern, characteristics of both the donor and the host. Since in most of these feathers the tip showed the color of one breed and the base that of the other, it at first seemed possible that during the operation appropriate parts of two different follicles had been fortuitously united to form a single composite structure. But the mosaic feathers proved to be too numerous and too perfectly formed for such an interpretation to be tenable, unless it were assumed in addition that there had been extensive reorganization of follicular tissue, or some unusual form of "induction."[3] A number of experiments designed to test these two possibilities gave wholly negative results. Later observations showed that while the same follicle might continue to produce mosaic feathers over a long period (as much as eight years), the successive feathers varied in the relative amount of donor and host components.[5] Study of many such feathers showed that those from the same follicle differed little except in color and pattern, being morphologically essentially identical (Figure 19). This left it very probable that the follicles from which mosaic feathers develop differ from others about them only in that they contain pigment cells of two distinct genotypes. In suitable material the two types of pigmentoblasts can be distinguished histologically.

Migration of Pigmentoblasts

Since no indication has been found of any foreign cells other than pigmentoblasts in these mosaic feathers, the natural inference has been that precursors of the pigment-producing cells migrate, or are brought, into the follicle at an early period and there establish centers of proliferation which contribute more or less to each new feather as it develops.[6] Skin-grafting experiments indicate that this migration may continue for at least several days after hatching. Whether the primordial cells are transported entirely by the blood stream as Champy[2] seems to believe, or more directly through the connective tissue is still uncertain.

Definite evidence in support of the view that pigmentoblasts reach their destination by migration is supplied by the important work of Willier and his coworkers[13, 14, 15] who find that when a piece of skin from the head region of a 75 hour embryo is transplanted to the base of the wing of an embryo of a different breed, the graft as a whole shows only normal increase in size, but the entire wing and adjacent parts of the body produce feathers with the form and growth rate of the host but the color

and pattern of the donor. Even when the donor is of the silky breed, the feathers produced by the host are entirely unmodified except in color. These findings seem to be in complete accord with those obtained from transplants made at the time of hatching except for two, probably minor, features. First, the spread of pigment is far greater in the early grafts than in the later ones. This seems to be only a difference in degree and is in accord with what perhaps might have been expected. Second, Willier and his associates find that the coloring of the first affected feathers is that of the donor, of later feathers that of both the donor and the host (mosaics) and of still later ones that of the host. In other words, it would appear that the foreign elements are gradually swamped and superseded by those which are proper to the host. Some slight tendency in this direction has been noticed a few times in grafts made after hatching, but why it should be less marked in grafts made late than in those made early is still unexplained.

Since the first draft of this paper was written an abstract by Dr. Mary Rawles[11] has appeared in which it is reported that the transfer of a bit of skin from the prospective head of a young robin embryo to the base of the wing of a White Leghorn embryo resulted in the appearance of robin pigment in typically Leghorn wing feathers. With this it would seem to have been demonstrated that during development avian pigmentoblasts do move from one place to another, sometimes coming to function in feathers remote from their site of origin.

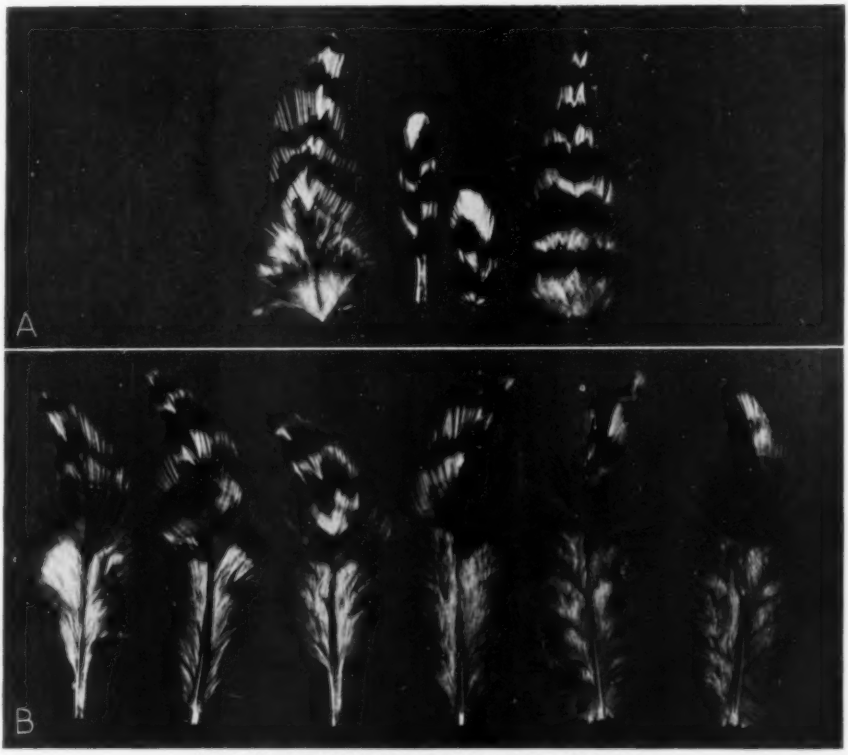
Hormones and Color

Another point of even greater interest is the relation of the pigmentoblasts to the organization of pattern. It is now well recognized that changes in form and color of feathers do not necessarily parallel each other following critical doses of theelin or thyroxin.[8] This, along with some genetic considerations, suggests the possibility that the color-pattern complex may be an essentially independent system reacting in its own way to humoral and other factors. The Barred Plymouth Rock type of plumage offers favorable material for testing this question.

The effect of the barring factor is to cause transverse white bands to appear in feathers that in the absence of this factor would be uniform in color, usually black. Since the gene for barring is sex-linked, the male with two of the genes is somewhat lighter than the female with only one.[9] While hormones may in a measure affect the pigmentation of either male or female feathers, at any given concentration the two sexes show the same relative differences (Figure 19). But this in itself, throws no light on whether the hormonal effects are on the pigmentoblasts or on some other tissue that orders their arrangement.

In seeking an answer to this latter question mosaic feathers are especially illuminating. In Figure 19*A* two such are shown. They grew on the margin of a graft from a White Leghorn male to a Barred Plymouth Rock female. The barred parts of the feathers have the markings of a Plymouth Rock female. This evidence is not entirely conclusive, however, since it might be suspected that these feathers were originally from the Plymouth Rock skin but had acquired a few of the inhibited White Leghorn pigmentoblasts at their tips. In the series of feathers shown in Figure 19*B* the evidence is more conclusive. Here the barred portions are black and pure white, or white somewhat invaded by red, but in no place are they barred red-and-white. If the barring were determined by any factor outside the pigmentophores, one would expect that if the feathers were originally Plymouth Rock the barring would involve the red areas (since red-and-white barring is a well-known pattern), or if they were originally Rhode Island Red the barring would be absent and the whole feather black and red only. Since neither of these combinations appears it would seem that the invading pigmentoblasts must be alone responsible for the pattern.

The evidence supplied by Willier and his associates, if we may interpret it, is



MOSAIC FEATHERS FROM SKIN GRAFTS

Figure 19

A. All four feathers are black and white. Left: Tip of a feather produced by skin of a Barred Plymouth Rock male grown as a graft on a Rhode Island Red male. Right: From Barred Plymouth Rock female skin grown on a Rhode Island Red male. The humoral environments in which these two feathers developed were presumably identical, the differences accurately reflecting male and female genotypes. The two middle feathers grew on the margin of a graft from a White Leghorn male to a Barred Plymouth Rock female. *B*. Six mosaic feathers from lines of contact between Barred Plymouth Rock and Rhode Island Red skin. The fluff, or under-color, of all of these is a clear rich brown, except for the one on the left in which it is partly white. The lower central part of the vane in each case is also brown (gray in the reproduction). The more distal portions are barred, black and white, the feathers to the left showing more of the Plymouth Rock component, those to the right more of the Rhode Island Red.

even more convincing, for they have shown that feathers obviously Leghorn in every particular, including rate of growth, show a typically Barred Plymouth Rock color pattern as a result of implanting a small bit of Plymouth Rock skin or even subjacent tissue[13] at a distance from the site of later observations. That this is not merely a question of activating Leghorn skin to reveal a hypostatic color pattern (many Leghorns do carry barring hypostatic to white) is shown if Rhode Island Red or hybrid skin is implanted in place of the pure Barred Plymouth Rock in which case subsequent feathers are colored but not barred.

The determination of color pattern by the pigmentoblasts which migrate into their definitive positions and orient them-

selves with reference to each other is not peculiar to birds alone as is shown by Twitty[12] in his studies on Triturus. Hybridization between *T. torosus, T. simulans* and *T. rivularis,* and reciprocal transplants in various combinations led him to conclude that the pattern of melanophore distribution is determined primarily by properties intrinsic to the pigment cells. In Triturüs, however, there are other genetic factors which may create conditions that in a measure limit the pigmentoblasts in the full expression of their genetic potentialities. To what extent similar factors are operative in developing feathers needs to be more fully determined.*

There are a number of minor differences in behavior between early transplants, chorio-allantoic grafts[4, 13] and grafts made after hatching. These in themselves present interesting problems. All the data thus far available seem to agree in pointing to the conclusion that the pigmentation of feathers is a phenomenon dependent in the main on highly autonomous migratory pigmentoblasts which determine not only the color but, through some capacity to orient themselves with reference to each other, the pattern as well. This concept makes a little more clear-cut some of the genetic and endocrine problems associated with the development of feathers.

Literature Cited

1. Asmundson, V. S. Note on a bronze-bourbon red mosaic. *Jour. Genet.* 35:25-30. 1937.

2. Champy, Ch. Recherches sur l'action des glandes genitales sur le plumage des oiseaux. *Arch. d'Anat. Micr.,* 31:145-270. 1935.

3. Danforth, C. H. The effect of foreign skin on feather pattern in the common fowl (Gallus domesticus). *Archiv. fur Entwicklungsmech.,* 166:242-252. 1929.

4. ————. Chorio-allantoic grafting followed by direct transplantation in the chick. *Proc. Soc. Exp. Biol. and Med.,* 27:1066-1068. 1930.

5. ————. Genetic mosaics in the feathers of the common fowl. *Trans. Dynamics of Develop.,* 10:339-344. 1935.

6. ————. Pigment cells in heterogenous feathers. *Anat. Rec.,* 68:461-468. 1937.

7. Danforth, C. H. and Frances Foster. Skin transplantation as a means of analyzing factors in production and growth of feathers. *Proc. Soc. Exp. Biol. and Med.,* 25:75-77. 1927.

8. Lillie, Frank R. The physiology of feather pattern. *Wilson Bulletin,* 44:193-211. 1932.

9. Montalenti, Giuseppe. A physiological analysis of the barred pattern in plymouth rock feathers. *Jour. Exp. Zool.,* 69:269-345. 1934.

10. Munro, S. S. A single chromosome explanation of Roberts and Quisenberry's brahma × barred rock mosaic. *Jour. Hered.,* 29:389-391. 1938.

11. Rawles, Mary E. The production of robin pigment in white leghorn feather cells by skin ectoderm grafts of the robin embryo. *Anat. Rec.,* Vol. 72, Supplement, p. 68. 1938.

12. Twitty, Victor C. Correlated genetic and embryological experiments on Triturus. *Jour. Exp. Zool.,* 74:239-302. 1936.

13. Watterson, R. L. On the production of feather color pattern by mesodermal grafts between barred plymouth rock and white leghorn chick embryos. *Anat. Rec.,* Vol. 72, Supplement, pp. 100-101. 1938.

14. Willier, B. H., Mary E. Rawles and E. Hadorn. Skin transplantation between embryos of different breeds of fowls. *Proc. Nat. Acad. Sci.,* 23:542-546. 1937.

15. Willier, B. H. and Mary E. Rawles. Feather characterization as studied in host-graft combinations between chick embryos of different breeds. *Proc. Nat. Acad. Sci.,* 24:446-452. 1938.

*In a significant paper before the American Association of Anatomists (*Anatomical Record,* Supplement, March, 1939, p. 43) Drs. Rawles and Willier presented convincing evidence that in Barred Plymouth Rocks, and therefore presumably in other birds, pigment formation is all predetermined in cells derived from areas which are known to form nerve tissue (i.e., from the neural crest), thus establishing a new and little suspected parallelism between birds and amphibians.

MANNOSE—
A New Taste "Thrill"

Six (more or less) delicious flavors in one pill — depending on who eats it. Adds interest and variety to the P. T. C. "Taster Test" which has been standard for several years to demonstrate inherited differences in taste perception. Send ten cents for a sample.

AMERICAN GENETIC ASSOCIATION

Victor Building **Washington, D. C.**

GET THIS RABBIT SELF-FEEDER!

Saves Time—Work—Feed!

THIS ALL-METAL SELF-FEEDER is being used by many rabbit breeders and by several large laboratories. It reduces time and work in feeding because all you have to do is fill it up and your feeding job is done for a couple of days. Tests at the Purina Research Rabbitry show that this feeder practically eliminates feed waste experienced when rabbits scratch feed out of crocks. You can get these feeders for 50c each, prepaid. Send in the coupon below to order feeders or to get complete information about Purina Rabbit Chows for rabbits and guinea pigs.

——————. TEAR HERE ——————

PURINA MILLS, Rabbit Dept.
922 Checkerboard Square, St. Louis, Mo.

Please send.....self-feeders, enclosed find 50c for each . . . or send sample diet and feeding directions for the following animals:

I keep about (No.).....Rabbits.....Guinea Pigs.....Rats.....Mice.....Dogs.

Name.....Dept.....

Institution.....Address.....

Material for Demonstrating Salivary Gland Chromosomes

Interrelated demonstration material—microscopic slides, chromosome maps, lantern slides and literature—make giant chromosomes available for classroom use.

MICROSCOPIC SLIDES OF SALIVARY GLAND CHROMOSOMES

Slide of Normal Salivary Chromosomes of *D. melanogaster*, each	$2.25
Three Slides	5.00
Slide with drawing identifying all chromosomes in two figures (Female)	4.00*
Slide showing Y-chromosome (Male)	4.00
Slide showing synapsis of normal and inverted X-chromosome (loop)	4.00*
Slide showing figure of an autosomal inversion	4.00*
Slide showing synapsis of translocated and normal chromosomes	4.00*
Slide showing a small deficiency (deletion)	4.00*
Salivary chromosomes of *D. virilis*	2.25
Three Slides	5.00
Normal Somatic (ganglion) chromosomes of *D. melanogaster*	2.50
(Magnification of at least 1000 × necessary to view satisfactorily.)	
1 Slide of each of above (9 slides—6 drawings)	25.00

* Three or more slides, 1 of each kind @ $3.50 each. Three or more of same kind @ $3.00 each.

SALIVARY GLAND CHROMOSOME MAPS

Painter's cytogenetic map of the salivary chromosomes, 9½ by 18 inches, line-cut showing major chromosome details and the genes approximately located to end of 1934, mailed unfolded	$ .50
Bridges' reference map of the banding of the salivary chromosomes, 9½ by 25 inches, halftone on heavy coated paper, unfolded	1.00
Bridges' Revised Map of the X-Chromosome—9½" x 18", unfolded	.75
Folded copies of Bridges' map, on lighter paper	.35
Hughes' map of Salivary Chromosomes of *Drosophila Virilis* (9½ by 18)	.75
Dobzhansky's map of Salivary Chromosomes of *Drosophila Azteca* (9½ by 18)	.75
1 copy each of Painter's Hughes' Dobzhansky's, and Bridges' two maps (5 maps in all)	3.00

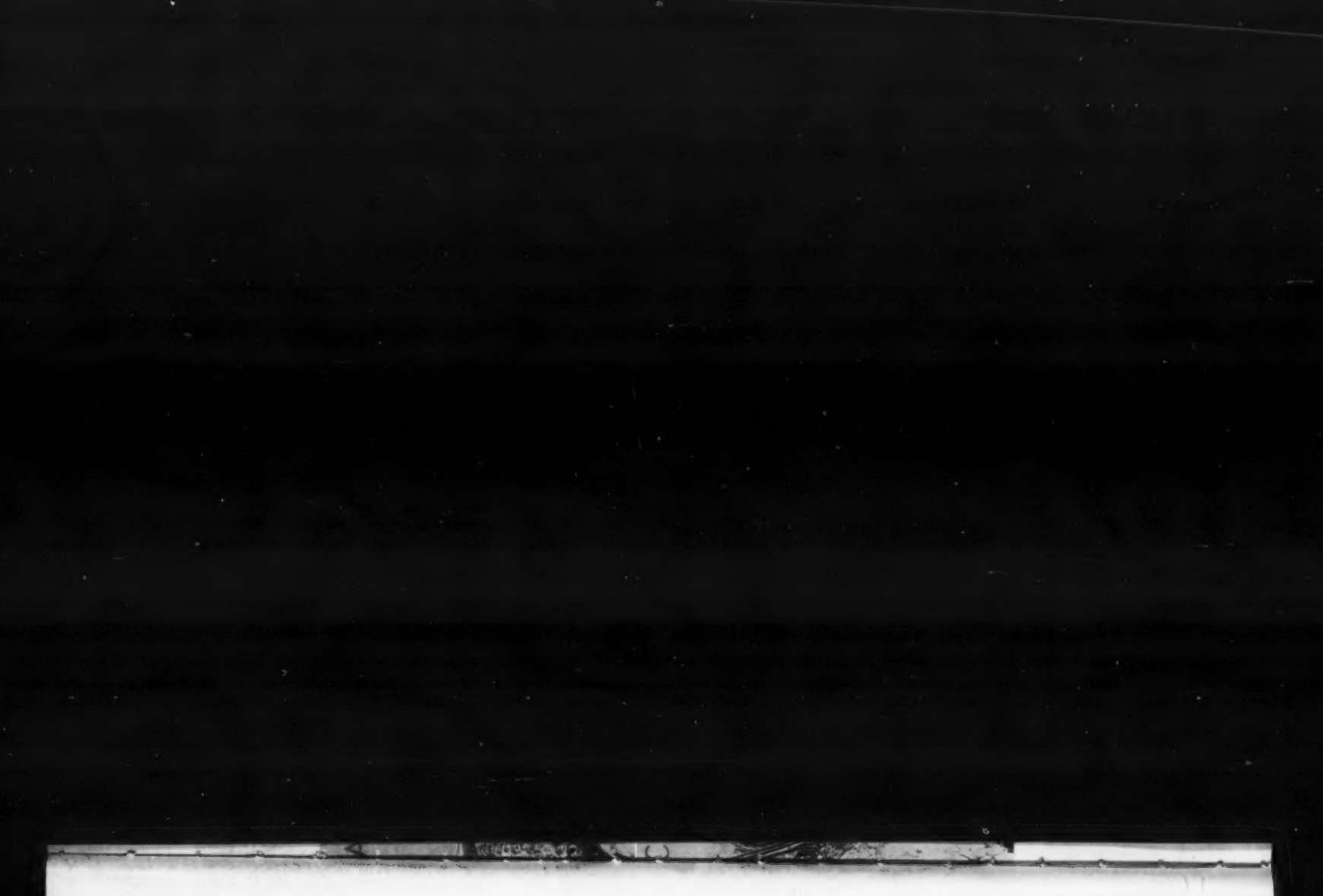
LANTERN SLIDES OF SALIVARY CHROMOSOME MATERIAL

†21-323. Salivary chromosomes in the Nucleus	$ .75
25-464. "Portrait" of a Salivary Gland Chromosome	.75
25-466. Giant Chromosomes Compared with "Normal", showing relative sizes	.75
25-469. Synapsis of Normal and Inverted Chromosomes	.75
25-470. Synapsis of Normal and Deleted Chromosomes	.75
25-472. Painter's Cyto-Genetic Map of Salivary Chromosomes (Insert)	.75
26-62. Salivary Chromosomes and Gonial Chromosomes Compared	.75
26-62. Bridges' Reference Map of the Salivary Chromosomes of Drosophila	.75
26-176. Salivary Gland Chromosomes of Sciara Compared with Normal	.75
26-178. The Entire Salivary Gland Showing Nuclei (Sciara)	.75
26-179. Salivary Gland Chromosomes in the Cell (Sciara)	.75
26-182. Structure of Salivary Gland Chromosomes	.75
27-206. Three Deficiencies of the X-Chromosome	.75
27-305. Map of Salivary Gland Chromosomes of *D. Virilis*	.75
29-12. Bridges' Revised Map of the S. G. X-Chromosome	.75
Set of 15 Lantern Slides	9.50
Any twelve of above lantern slides	8.00

† Volume and page number of illustration in the JOURNAL OF HEREDITY.

ILLUSTRATED LITERATURE

"Symposium Reprint" on Salivary Gland Chromosomes, containing articles from the JOURNAL OF HEREDITY, 1934-1938, by Painter, Bridges, Metz, Mackensen and Hughes—four Salivary Gland Chromosome maps, 15 illustrations, 54 pages $3.00

AMERICAN GENETIC ASSOCIATION

Victor Building **Washington, D. C.**